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TO THE

EXECUTIVE DOCUMENTS

OF THE

HOUSE OF REPRESENTATIVES

FOR THE

SECOND SESSION OF THE FORTY-FIFTH CONGRESS,

1877-'78.

IN 22 VOLUMES.

VOLUME XIV.—Nos. 34 to 72, except Nos. 34, 39, 51, and 61.

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45TH CONGRESS, 2d Session. } HOUSE OF REPRESENTATIVES. { EX. DOC. No. 34.

INTEREST PAID TO NATIONAL BANKS.

LETTER

FROM

THE SECRETARY OF THE TREASURY

TRANSMITTING,

In compliance with House resolution, a statement of the sums paid for interest, in coin and currency, upon bonds held by national banks.

JANUARY 28, 1878.—Referred to the Committee on Banking and Currency and ordered to be printed.

TREASURY DEPARTMENT,
January 25, 1878.

SIR: I have the honor to transmit herewith, in compliance with a resolution of the House of Representatives, of date the 17th instant, a letter of the United States Treasurer stating "the sums, and the date thereof, which have been paid by the Government of the United States in interest, in coin and currency, to the national banks upon bonds held for the security and the redemption of the currency issues of said banks."

Very respectfully,

JOHN SHERMAN,
Secretary.

HON. SAMUEL J. RANDALL,
Speaker House of Representatives.

Statement of the dates of payment and the amounts of coin and currency paid by the Government of the United States to the national banks on account of interest on the bonds held for the security of the circulating notes of said banks from July 1, 1863, to January 1, 1878.

COIN INTEREST.

Date of payment.	Amount.	By fiscal years.
July 1, 1863	$817 50	
November 1, 1863	175,543 50	
January 1, 1864	9,697 50	
May 1, 1864	887,890 50	
		$1,073,949 00
July 1, 1864	103,812 50	
September 1, 1864	254,472 50	
November 1, 1864	1,335,273 00	
January 1, 1865	1,088,334 50	
March 1, 1865	897,017 50	
May 1, 1865	2,171,175 00	
		5,850,085 00
July 1, 1865	2,379,880 00	
September 1, 1865	1,859,916 25	
November 1, 1865	3,215,826 00	
January 1, 1866	2,926,537 00	
March 1, 1866	2,150,705 00	
May 1, 1866	3,915,160 50	
		16,448,024 75
July 1, 1866	3,051,852 00	
September 1, 1866	2,243,618 75	
November 1, 1866	4,152,174 00	
January 1, 1867	3,201,370 50	
March 1, 1867	2,312,820 00	
May 1, 1867	4,121,946 00	
		19,083,781 25
July 1, 1867	3,334,227 00	
September 1, 1867	2,305,782 50	
November 1, 1867	4,013,793 00	
January 1, 1868	3,349,521 00	
March 1, 1868	2,350,418 75	
May 1, 1868	3,970,792 50	
		19,324,534 75
July 1, 1868	3,292,281 00	
September 1, 1868	2,320,258 75	
November 1, 1868	3,899,791 50	
January 1, 1869	3,251,853 00	
March 1, 1869	2,256,281 25	
May 1, 1869	3,802,372 50	
		18,822,838 00
July 1, 1869	3,227,464 00	
September 1, 1869	2,366,158 75	
November 1, 1869	3,563,817 00	
January 1, 1870	3,329,441 00	
March 1, 1870	2,421,352 50	
May 1, 1870	3,489,343 50	
		18,397,576 75
July 1, 1870	3,347,458 00	
September 1, 1870	2,452,865 00	
November 1, 1870	3,405,927 00	
January 1, 1871	3,490,958 50	
March 1, 1871	2,627,990 00	
May 1, 1871	3,329,949 00	
		18,655,147 50
July 1, 1871	3,697,759 00	
August 1, 1871	615,970 63	
September 1, 1871	2,628,031 25	
November 1, 1871	2,324,089 50	
January 1, 1872	3,609,661 00	
February 1, 1872	1,172,296 25	
March 1, 1872	2,573,471 25	
May 1, 1872	2,405,342 87	
		19,096,621 75
July 1, 1872	3,593,626 00	
August 1, 1872	1,312,464 38	
September 1, 1872	2,645,868 75	
November 1, 1872	2,425,685 62	
January 1, 1873	3,642,575 50	
February 1, 1873	1,332,298 12	
March 1, 1873	2,673,011 25	
May 1, 1873	2,299,062 62	
		19,924,592 24

Statement of the dates of payment and the amounts of coin and currency paid, &c.—Cont'd.

COIN INTEREST—Continued.

Date of payment.	Amount.	By fiscal years.
July 1, 1873	$3,641,513 00	
August 1, 1873	1,539,566 25	
September 1, 1873	2,693,436 25	
November 1, 1873	2,251,110 75	
January 1, 1874	3,636,044 00	
February 1, 1874	1,610,608 75	
March 1, 1874	2,697,497 50	
May 1, 1874	2,263,075 25	
		$20,332,851 75
July 1, 1874	3,556,030 00	
August 1, 1874	1,634,173 12	
September 1, 1874	2,632,311 25	
November 1, 1874	2,255,721 12	
January 1, 1875	3,320,769 00	
February 1, 1875	1,741,928 12	
March 1, 1875	2,572,752 50	
May 1, 1875	2,289,898 75	
		20,007,503 86
July 1, 1875	3,164,214 00	
August 1, 1875	1,740,296 25	
September 1, 1875	2,493,842 50	
November 1, 1875	2,151,967 63	
January 1, 1876	3,017,872 50	
February 1, 1876	1,807,853 75	
March 1, 1876	2,406,247 50	
May 1, 1876	1,956,909 75	
		18,738,503 88
July 1, 1876	2,751,202 50	
August 1, 1876	1,738,398 75	
September 1, 1876	2,303,622 50	
November 1, 1876	1,804,301 00	
December 1, 1876	126,682 87	
January 1, 1877	2,704,381 50	
February 1, 1877	1,689,281 25	
March 1, 1877	2,387,001 62	
May 1, 1877	1,637,690 38	
June 1, 1877	447,932 25	
		17,590,494 62
July 1, 1877	2,386,989 00	
August 1, 1877	1,562,969 37	
September 1, 1877	2,395,466 25	
October 1, 1877	128,545 50	
November 1, 1877	1,552,724 38	
December 1, 1877	501,680 81	
January 1, 1878	2,477,391 00	
		11,005,766 31
Total coin interest		244,278,271 41

CURRENCY INTEREST.

July 1, 1865	$7,500 00	
January 1, 1866	26,940 00	
		$34,440 00
July 1, 1866	92,040 00	
January 1, 1867	107,310 00	
		199,350 00
July 1, 1867	107,310 00	
January 1, 1868	107,310 00	
		214,620 00
July 1, 1868	197,100 00	
January 1, 1869	460,680 00	
		657,780 00
July 1, 1869	555,690 00	
January 1, 1870	555,690 00	
		1,111,380 00
July 1, 1870	532,200 00	
January 1, 1871	487,500 00	
		1,019,700 00
July 1, 1871	467,580 00	
January 1, 1872	455,280 00	
		922,860 00
July 1, 1872	438,060 00	
January 1, 1873	423,000 00	
		861,060 00
July 1, 1873	423,000 00	
January 1, 1874	422,640 00	
		845,640 00

Statement of the dates of payment and the amounts of coin and currency paid, &c.—Cont'd.

CURRENCY INTEREST—Continued.

Date of payment.	Amount.	By fiscal years.
July 1, 1874	$422, 640 00	
January 1, 1875	399, 210 00	
		$821, 850 00
July 1, 1875	394, 590 00	
January 1, 1876	378, 525 36	
		773, 115 36
July 1, 1876	333, 150 00	
January 1, 1877	289, 140 00	
		622, 290 00
July 1, 1877	242, 610 00	
January 1, 1878	232, 590 00	
		475, 200 00
Total currency interest		8, 559, 285 36

RECAPITULATION.

Coin interest	$244, 278, 271 41	
Currency interest	8, 559, 285 36	
Total		$252, 837, 556 77

TREASURY OF THE UNITED STATES,
January 25, 1878.

COMPENSATION OF INSPECTORS OF CUSTOMS.

LETTER

FROM

THE SECRETARY OF THE TREASURY,

TRANSMITTING

A copy of a letter from the Commissioner of Customs, proposing an alteration of certain sections of the Revised Statutes, fixing the compensation of Inspectors of Customs, &c.

JANUARY 29, 1878.—Referred to the Committee of Ways and Means, and ordered to be printed.

TREASURY DEPARTMENT,
January 28, 1878.

SIR: I have the honor to transmit herewith a copy of a letter of the 25th instant from the Commissioner of Customs, proposing an alteration of certain sections of the Revised Statutes, fixing the compensation of inspectors of customs, and providing for the payment into the Treasury of the gross proceeds of old material sold. His suggestions meet my hearty concurrence, and I respectfully recommend their adoption.

Very respectfully,

JOHN SHERMAN,
Secretary.

Hon. S. J. RANDALL,
Speaker House of Representatives.

[Copy.]

TREASURY DEPARTMENT,
OFFICE OF COMMISSIONER OF CUSTOMS,
Washington City, D. C., January 25, 1878.

SIR: I have the honor to inclose herewith the form of an enactment designed to make the law contained in sections 2733 and 2737, Revised Statutes, relating to the salary of inspectors of customs, the same as it was prior to the passage of the Revised Statutes, and of an amendment to section 3618, relating to the sale of old material.

Prior to the passage of the Revised Statutes, the law allowed the Secretary of the Treasury to fix the compensation of inspectors at such sum

as he saw fit, not however to exceed the maximum per diem of three dollars, with the power of increasing this maximum to four dollars.

Under this law inspectors were in some cases paid as little as fifty cents a day, with perfect satisfaction both to the government and the party employed.

In section 2733, Revised Statutes, the discretionary power of the Secretary of the Treasury in relation to the compensation of inspectors is omitted, and a fixed sum—viz, three dollars—is named for every day's work by an inspector.

In order to prevent an increase of the expenses of collecting the revenue from customs, and at the same time to keep the force of inspectors intact, the designation of those receiving less than $3 a day was changed from inspectors to deputy collectors, or the time to be employed limited; thus, John Smith, deputy collector and inspector, at $3 a day when employed, not to exceed $600 a year. It is believed, however, that many of the employés so appointed in reality perform service the whole time, and are laying the foundation for claims hereafter to be brought before the Treasury.

It is to prevent the possibility of such claims, to allow greater economy to be practiced in the collection of the revenue, and to restore the law to its former basis, that this change in the law is proposed.

Under section 3618, as it is at present construed, if an officer of the Treasury is ordered to sell old material, he must do so at his own expense, as the *gross* proceeds are required to be deposited without any deduction on account of charges, and there is no appropriation for the payment of bills of this nature.

It is to cure this palpable injustice that the amendment to section 3618 is suggested.

Very respectfully, your obedient servant,

H. C. JOHNSON,
Commissioner of Customs.

Hon. JOHN SHERMAN,
Secretary of the Treasury.

SUBSTITUTE FOR SECTIONS 2733 AND 2737, REVISED STATUTES.

Each inspector shall receive for every day he shall be actually employed in aid of the customs such sum as the Secretary of the Treasury may direct, not to exceed three dollars; and the Secretary of the Treasury may increase the compensation of such inspectors as he may think advisable to a sum not exceeding four dollars for each day actually employed.

Sections 2733 and 2737, Revised Statutes of the United States, are hereby repealed.

CONSTRUCTION OF SECTION 3618.

Section 3618, Revised Statutes of the United States, shall be construed to allow the payment of all proper charges for the advertisement, storage, handling, and sale of old material or other public property, out of the proceeds derived from such sale before they are deposited and covered into the Treasury.

JETTIES SOUTH PASS, MISSISSIPPI RIVER.

LETTER

FROM

THE SECRETARY OF WAR,

RELATIVE TO

The report of M. R. Brown, captain of Engineers, relating to the work of Mr. Eads at South Pass, Mississippi River.

JANUARY 29, 1878.—Recommitted to the Committee on Commerce and ordered to be printed.

WAR DEPARTMENT,
Washington City, January 16, 1878.

SIR: I have the honor to report, for the information of Congress, that under the provisions of paragraphs two and ten of the fourth section of the river and harbor act of March 3, 1875 (18 Stat., pp. 463–466), I have made requisition upon the Secretary of the Treasury for the second payment of $500,000 in favor of James B. Eads, and to transmit the documents on which this action is based.

In my annual report, dated November 19, 1877, I stated as follows:

In order to enable this department to carry into effect, on behalf of the United States, the provisions of the act of Congress authorizing James B. Eads to construct such jetties and other auxiliary works as are necessary to permanently maintain a wide and deep channel from the Mississippi River through the South Pass to the Gulf of Mexico, an officer of the Corps of Engineers is stationed at the South Pass, with instruction to report from time to time the nature and condition of the work in progress, the depth of water and width of channel secured and maintained.

The reports of March 16, 1877, and July 24, 1877, showing the condition of the work at those dates, and not heretofore communicated to Congress, are herewith transmitted. On the 31st of October a subsequent report, also transmitted herewith, showed a 20-foot channel at average flood-tide through the bar, and throughout the pass and between the jetties, with a least width of 210 feet. The interruption to navigation for a vessel drawing 22 feet was 430 feet in length, and the channel was, with this exception, at least 160 feet wide. When a channel 22 feet in depth and 200 feet in width shall have been attained, a further sum of $500,000 will become due; and in respect to the time of the probable attainment of this depth, the Engineer inspecting-officer reports:

"It is probable that the aid of the new dredge-boat, if it is moderately successful, may soon enable Mr. Eads to gain a channel 22 feet deep for a width of 200 feet, throughout the jetties, and the chances are quite favorable for the attainment of such a channel in the early stages of low river, by the help, possibly, of only an ordinary dredging-machine, and later, perhaps, even without such aid. These statements are made because the law (act approved March 3, 1875) requires that the honorable Secretary of War shall 'embody in his annual reports the probable time when other payments will become due.'"

Provision for this payment is made in the sundry civil act of March 3, 1877, vol. 19, p. 358, provided it becomes due prior to 1st of February, 1878. Should the contingency arise subsequent to that date, it would appear that further provision must be made by Congress for the payment.

It having been officially reported to me that there was an open channel of greater depth than 18 feet at mean tide to and from the sea through the South Pass to the port of New Orleans, I directed, August 18, 1877, the suspension of the operations for the deepening of the Southwest Pass under the appropriation of August 14, 1876, in compliance with the provisions of that act.

The accompanying report of Capt. M. R. Brown, the officer of Engineers detailed under the act to make inspections, &c. (vice Maj. C. B. Comstock, on leave of absence), contains the certified statement required by the act above referred to, that on "December 15, a channel 22 feet deep, throughout a width of more than 200 feet at its narrowest point, was obtained from deeper water in South Pass near the Head of Passes, through the jettied prolongation of South Pass to deeper water in the Gulf of Mexico."

The inclosed copy of report of Col. J. G. Barnard and Lieut. Col. H. G. Wright, of the Corps of Engineers, dated January 5, 1878, confirms the statement of Captain Brown above quoted.

The conditions of law having been fully complied with, I am informed that payment of the sum authorized has been made by the Treasury Department.

Very respectfully, your obedient servant,

GEO. W. McCRARY,
Secretary of War.

The SPEAKER *of the House of Representatives.*

UNITED STATES ENGINEER OFFICE,
PORT EADS, SOUTH PASS, LA.,
December 17, 1877.

SIR: I have the honor, in compliance with the act of Congress approved March 3, 1875, entitled "An act making appropriations for repairs, preservation, and completion of certain public works on rivers and harbors, and for other purposes," to report, in confirmation of my telegram of yesterday, that "yesterday, December 15, a channel 22 feet deep, throughout a width of more than 200 feet at its narrowest point, was obtained from deeper water in South Pass near the Head of the Passes, through the jettied prolongation of South Pass to deeper water in the Gulf of Mexico."

I have also furnished Mr. Eads with a duplicate of this letter.

Not over one day's field work will be required to complete the pending survey, and after a few days' office-work, following the taking of soundings in the Gulf near the ends of the jetties, certified charts with others will be forwarded to the honorable Secretary of War and to Mr. Eads, and at that time or soon after a report to accompany the charts will be mailed to both addresses.

I certify that the facts above stated, as to widths and depths of channel, are correct, and in conformity with the results of my latest surveys.

Very respectfully, your obedient servant,

M. R. BROWN,
Captain of Engineers, U. S. A.

Hon. GEORGE W. McCRARY,
Secretary of War, Washington, D. C.

NEW ORLEANS, LA., *January* 5, 1878.

SIR: In compliance with your orders of the 21st ultimo, we proceeded to Port Eads, arriving there Sunday evening, December 30, 1877, and made "a personal and thorough examination of the work now in progress, under charge of James B. Eads, for the improvement of the South Pass of the Mississippi River," and have the honor to report as follows:

Before proceeding to more general views and recommendations, we present the following answers to your interrogatories:

Interrogatory 1. "What depth and width of channel have been secured through the South Pass of the Mississippi River to deeper water in the Gulf of Mexico?"

Answer. There is a channel nowhere less than 200 feet wide and 22 feet deep from the South Pass between the jetties to the deep water of the Gulf of Mexico, the width between the 22-foot curves varying from 200 feet to more than 500 feet. A practicable channel of 22.4 feet exists through the whole extent of this portion of the pass. At the Head of the Pass a channel 264 feet wide and 22 feet deep exists, and a practicable channel of 23 feet deep is also found. As to the main body or length of the pass, we would respectfully refer to the report of July 24, 1877 (the seventh), "upon the improvement of the South Pass of the Mississippi River." Some changes are shown to have occurred in widths and depths since Marinden's U. S. Coast Survey in 1875, but none material to be considered at present.

Interrogatory 2. "Has such depth and width of channel been obtained by the action of such jetties and auxiliary works as are contemplated by the terms of the act of Congress aforesaid?"

Answer. Section 4 of the aforesaid act authorizes James B. Eads and associates "to construct such permanent and sufficient jetties and such auxiliary works as are necessary to create and permanently maintain, as hereafter set forth, a wide and deep channel between the South Pass of the Mississippi River and the Gulf of Mexico, and for that purpose he may construct in the river outlet or pass, and likewise in the Gulf of Mexico, such walls, jetties, dikes levees, and other structures, and employ such boats, rafts, and appliances as he may, in the prosecution of said work, deem necessary."

Section 5 of same act provides (among other things) that "when a channel of twenty feet in depth and of not less than two hundred feet in width shall have been obtained by the action of said jetties and auxiliary works, five hundred thousand dollars shall be paid; and when a channel of twenty-two feet in depth and two hundred feet in width shall have been obtained by the action of said jetties and auxiliary works, five hundred thousand dollars shall be paid," &c.

We have already, in our answer to the first interrogatory, reported that a channel "twenty-two feet in depth and two hundred feet in width" has been obtained. The interrogatory now to be answered is, "has such depth and width been obtained by the action of such jetties and auxiliary works as are contemplated by the terms of the act of Congress?"

The condition of payment, *i. e.*, that the specified depth and width shall be obtained by the action of "such jetties and auxiliary works," leads us into the consideration of what is meant by auxiliary works. As *these*, in the language of the law, are coupled with the "permanent and sufficient jetties" which are to be constructed, and as further on he is more specifically authorized to *construct* in the river outlet or pass,

and likewise in the Gulf of Mexico, "such walls, jetties, dikes, levees, and other structures," &c., all of which appear to be structures fixed in location and attached to the bottom of the river, outlet, or pass, or as levees to the dry land, a rigid interpretation would appear to exclude the use, or rather to prohibit payment for channel depths and widths obtained with the *aid* of the well-known processes of "scraping," "stirring up the bottom," or "dredging," and there can be no doubt that had either or all of these last-named means been the main agent or agents of obtaining the specified depths, payment could not, under the conditions of the law, be made for channel widths and depths so obtained, the jetty principle being notoriously the principle to be applied by the grantee.

If, however, we refer to authoritative statements of the methods of applying that principle, we find it stated in the Physics and Hydraulics of the Mississippi River (p. 489, *reprint*), in treating of the "Plan of jetties," that the "erosive action should be aided at first by dragging and scraping the hard portion of the bar."

The Board of Engineers appointed by the President of the United States, under the act of Congress of June 23, 1874, to make "a survey of the mouth of the Mississippi River, with a view to determine the best method of obtaining and maintaining a depth of water sufficient for the purposes of commerce, either by a canal from the said river to the waters of the Gulf or by deepening one or more of the natural outlets of said river," in recommending the opening of the South Pass by the application of the jetty system, states, "by aiding, if necessary, by dredging, we should be able to reduce at pleasure the time required for the process"; and again: "This plan is then adopted, * * * to begin parallel dikes (*i. e.*, jetties) at the banks, and carry them over the bar to 30 feet water outside, * * * allowing the river to erode the bottom between the dikes, * * * aiding the erosion by dredging or stirring, if it is not rapid enough." And in appendix to their report an item of $250,000 is found as the "estimated cost of dredging or stirring in aiding formation of channel between the jetties and at the Head of the Pass."

The object of the act we are now considering is to "create and permanently maintain a wide and deep channel between the South Pass of the Mississippi River and the Gulf of Mexico"; and the Board of Engineers alluded to having been constituted expressly to determine the best manner of creating and maintaining such a channel, after having personally examined the most important works of Europe, recommended the jetty plan to be applied to the South Pass; and the report and estimate of that board being the basis upon which the compensation to Eads and associates was determined, we do not doubt that the real intention of the proviso in question was that jetties and auxiliary *works* should be the *effectual* agents of obtaining the "wide and deep channel" intended, while at the same time the references we have made show that dredging is a legitimate auxilary.

We conceive, therefore, that the true intent of the proviso does not prohibit the auxiliary aid of dredging; that its spirit is as above defined; and that, indeed, in the authorizing of the employment of such boats, rafts, and appliances as he may, in the "prosecution of said work, deem necessary," *allows* dredging, and should not prohibit payment for channel widths and depths which the jetties and auxiliary works have, to all intents and purposes, really created, and to which dredging has been slightly auxiliary.

If we look at the actual facts presented by the prosecution of this work, we find that where, two and a half years ago, there was a bar at the mouth of the South Pass of over two miles of extent measured from 22 feet water inside to the same depth outside, over about half a mile of which there was but eight feet of water, a "wide and deep channel" of 22 feet depth now exists, and a result inferior in physical magnitude but no less in importance at the Head of the Passes has been obtained. And these results are so exclusively due to the "jetties and auxiliary works," that the auxiliary aid of "appliances," if in such we include dredging-machines, is utterly insignificant, consisting mainly indeed in a slight widening at two points and widening and deepening at a third. By the erosion of the current, due entirely to the jetties and their fixed auxiliaries, about two and one half millions of cubic yards of bottom material have been removed, leaving in its place the "wide and deep channel." Of this amount, one million of cubic yards have been removed by the same agency since the twenty feet of depth on the bar was obtained.* By the action of the dredge-boats (see Captain Brown's recent report to the honorable Secretary of War), *from twelve to twenty-eight thousand* cubic yards have nominally been removed by dredging.† But it cannot positively be asserted that to the creation of the channel now existing even this insignificant amount has been contributed by dredging. It is pertinent to remark, in this connection, that the creating of the 200 feet width of the 20-foot channel, for which payment has already been made, is officially reported to have been, to a small extent, aided by dredging. (See Major Comstock's sixth report.)

We have discussed the point of dredging at much length, because we conceive it to be the real one involved in the third interrogatory; and we conclude by answering that, according to the construction above given, the depth and width of channel has been obtained by the action of such jetties and auxiliary works as are contemplated by the terms of the act of Congress.

Interrogatory 3. "Are the jetties and auxiliary works constructed or in process of construction permanent, sufficient, and thoroughly substantial, within the meaning of said act of Congress?"

Answer. In section 13, of the aforesaid act it is provided, "that while said Eads shall be untrammeled in the exercise of his judgment and skill in the location, design, and construction of said jetties and auxiliary works, the intent of this act is not simply to secure the wide and deep channel first above named, but likewise to provide for the construction of thoroughly substantial and permanent works."

And, further, that if the commission specified in same section "shall report that the works are being constructed upon a "design that will not be of a substantial and permanent character when completed," &c.; which seems to imply that at a stage of the work like the present it was not expected that the works should be brought to a condition of permanency, but only that, so far as they have gone, they should be of such a character as to be both substantial and permanent when completed according to the design.

Moreover, the Commission of Engineers constituted by Special Orders

* It must be remarked that the figures in the text by no means exhibit the actual *channel-scour* due to the jetties and auxiliary works. They exhibit merely the *balance* between *scour* and *fill*, the *fill* occurring almost exclusively in the ultra-channel spaces, between the wing-dams. By reference to Captain Brown's report, it will be seen that an abnormal scour of one and a half millions of cubic yards took place last summer in an extent between jetties of only about 2,000 feet, between 4,500 and 6,500 feet below East Point.

† When dredging commenced, Captain Brown estimated only twelve thousand cubic yards o excavation to be needed to produce the required channel width and depth.

No. 229, Adjutant-General's Office, Washington, November 2, 1876, reported on this point as follows:

> We do not conceive it to be required of Mr. Eads that each stage of the progress shall exhibit such "substantial and permanent work" as the law ultimately contemplates, but rather that each stage of the work shall show an adequacy to create a channel of the depth and width demanded, and, at the same time, such a fair and honest prosecution of the work as shall be, as far as it has gone, so much really accomplished toward the construction of works which, in the language of the law, may be maintained for all time after their completion.
>
> While we believe that Engineer officers, applying moneys appropriated to meet their estimates by Congress, would have executed their work differently, especially in applying freely stone to each layer of mattresses, we are nevertheless of opinion that the work is being constructed essentially according to the spirit of the act, as mentioned in the tenth (thirteenth) section thereof.

The above view of the case was approved by the honorable Secretary of War and sustained by the decision of the Attorney-General of the United States. (See Ex. Doc. 28, 44th Cong., 2d sess., H. R.)

Adopting the view above expressed, which, in our judgment, is the only equitable one, we answer this interrogatory in the affirmative. No part of the jetties are as yet entirely completed, and some portions, especially the outer ends, will require extension of width and a large amount of stone before they are brought to that permanent and substantial condition when completed which the act, in our judgment, requires. This additional work, we understand, Mr. Eads and associates propose to do from time to time, as payments are made to them by the United States.

Interrogatory 4. "Have the conditions prescribed in said act of Congress been fully complied with by said James B. Eads, in so far as he has proceeded with the work?"

Answer. In our judgment the conditions imposed by the act have been complied with by James B. Eads and associates, so far as they have proceeded with the work.

Interrogatory 5. "Is James B. Eads, in your opinion, entitled to receive the $500,000 which, by the terms of said act, was to be paid to him when, having fully complied with the conditions prescribed by said act, a channel of twenty-two feet in depth and two hundred feet in width shall have been obtained by the action of said jetties and auxiliary works?"

Answer. We are of opinion that James B. Eads is entitled to receive the payment of $500,000 specified in the above interrogatory; and our reasons will be found in the answers already given to the first, second, third, and fourth interrogatories.

In conclusion, we submit the following general views and recommendations:

The recent report of the Engineer Officer in charge, dated December 23, 1877, now in your hands, gives so exhaustively every detail connected with the work, that we need but refer to that report, and to those which immediately precede it, for full information concerning the history of the work, the manner of construction, and the present condition. It, therefore, seems only necessary for us to take up two or three topics which have especial importance in the present stage of the work.

We have already quoted from the report of the commission constituted November 2, 1876, in reference to the clause demanding "substantial and permanent works, by which said channel may be maintained for all time after their completion"; a provision which refers to the character of the works as incidental to the maintenance "for all time"

of the *channel*. In the paragraph following the quotation referred to from the commission's report, the following occurs:

We would add that the greatest variation from the sectional designs of the board of 1874 for the jetties is to be found on their sea-sides. That board recommended that the jetties should have on their sea-sides the same slopes as on the river or channel side. As actually built upon the foundation mattressed, the sea-sides are vertical. This construction appears to answer every purpose throughout most of the length, for the wide shoals on each side afford great protection, and there is, as had been expected, a great accumulation of river-sediment and loam deposit against the exterior of the jetties, by which that protection is augmented. The outer ends of the two jetties, and especially the end of the eastern one, extend beyond their protection, and are greatly exposed; and we deem that an enlargement of section and a large application of stone to be essential to security.

We have already remarked that we deem, not only an enlargement of section, but a large application of stone to be essential to the security of the jetties, their sea-ends especially; and we are of the opinion that this enlargement of sections at the sea-ends and consolidation throughout by the application of stone should be undertaken at once, and a reasonable progress therein be made the condition of the second and all future payments. The immediate and full consolidation of the jetties should be neither required nor expected, as they will continue to settle for some time, both by subsidence of the bottom upon which they rest and by the compression of the mattresses of which they are largely composed. But this settlement and consolidation should be hastened, as has just been remarked, by the application of stone from time to time, so that they may be in condition to receive their final finish as soon, at least, as the expected full depth of water in the channel has been obtained.

Since the date of the report referred to, considerable quantities of stone (see Captain Brown's report of December 23, 1877, for exact quantity) have been laid along the jetties, some considerable portions of which may be regarded as requiring no further additions for a long time, if at all.

With regard to the sea-ends, however, a much larger application of stone will still be necessary, but the defect of vertical sea-sides has not yet been remedied, nor has the required enlargement of section, to any great extent, been made. Nevertheless, these ends have maintained themselves so as to suffer only from subsidence of the bottom compression of the mattresses and superficial abrasion by storms.

It is understood to be Mr. Eads's intention to enlarge and strengthen these sea-ends in accordance with the views above expressed.

The report of Captain Brown gives all the particulars attainable by him concerning the ravages of the teredo. We caused to be broken by pull of a tug-boat one of the piles of the east jetty head (a round pine stick about one foot in diameter, which had been in place more than two years), the fracture occurring about eight feet below low-water line and not far from the bottom. At this point the teredo had penetrated so as to leave but five or six inches of sound central core, external to which the worms, some of large size, had eaten away much of the substance. This fact confirms what had been inferred by Captain Brown, that seaward of station 100, on East jetty, all timber five feet below low water, not buried in the bottom or surrounded by deposited sediment, will ultimately be consumed by worms. But this fact does not imply that the foundation mattresses, well buried in the sand, will not remain sound; neither that those which, in the body of the jetties, are well packed around with sediment will not equally remain so.

Further observation and longer experience are necessary to a full development of the question involved; but it is believed that when the lateral slopes of stone are fully provided the penetration of the worm into the interior of the jetties in these salt-water exposed parts will be checked, and that to the extent to which they may be impaired, the remedy will be found in the increase of the quantity of stone.

By reference to Captain Brown's report, it will be observed that the

ends of the opposite wing-dams have generally a less interval between them than 700 feet. Section 9 of the act of Congress requires that the said jetties "shall not be less than 700 feet apart." On this point Captain Brown states, in the seventh report, "that it has been assumed by my predecessor, I think, and it certainly has been assumed by me, that any narrowing of the water-way to a less width than 700 feet was a temporary expedient, to gain an increase of velocity which should aid in scouring away speedily a material, mostly of hard clay, which has been compacted by years of inertness under both mechanical and chemical laws, and should secure the first desired depths sooner than they could be obtained without the diminution of the water-way; and I have assumed that it was the intention of Captain Eads to remove any obstructions to a water-way 700 feet wide ultimately. In this assumption I am orally confirmed by Captain Eads himself."

The letter of the law quoted above speaks only in prescribing the interval of 700 feet of the location of "the said *jetties*," the only instance, except one, in which in the numerous repetitions, the word *jetties* is without the sequence of the words "and auxiliary works," and it seems clear that the language applies to the location of the main works, "the jetties," and not to auxiliary works (*e. g.*, wing-dams, &c.). Whether or not a clear water-way of 700 feet is *intended*, we are not now called upon to decide.

The jetties themselves, as located and so far constructed, are really 1,000 feet apart. The existing wing-dams are avowedly temporary expedients, the ultimate removal of which—or, at least, of so much of which as may be necessary to exhibit the aforesaid clear water-way—is the announced intention of the grantee. With present channel-widths the contraction of total water-way is no detriment to navigation.

Respectfully submitted.

J. G. BARNARD,
Colonel of Engineers and Brevet Major-General.
H. G. WRIGHT,
Lieutenant-Colonel of Engineers and Brevet Major-General.

Hon. GEORGE W. MCCRARY,
Secretary of War, Washington D. C.

TREASURY DEPARTMENT,
OFFICE OF THE LIGHT-HOUSE BOARD,
Washington, November 24, 1877.

SIR: Referring to your letter of November 12, I have to say that the Light-House Board, at its meeting of November 23, considered the matter of lighting the jetties at the South Pass of the Mississippi River, and while the board is of the opinion that lights are necessary for safe navigation, it is powerless to act in the matter for want of the necessary appropriation. The board is of the opinion that an appropriation of $10,000 should be made for such lights. It will require but a short time to establish them after an appropriation is made.

Very respectfully,

PETER C. HAINS,
Engineering Secretary.

Capt. JAMES B. EADS,
Care of Mr. R. S. Elliott, 316 *C Street, Washington, D. C.*

OCEAN MAIL STEAMSHIP SERVICE OF FOREIGN COUNTRIES.

LETTER

FROM

THE POSTMASTER GENERAL,

IN COMPLIANCE WITH

A resolution of the House of Representatives, transmitting a tabular statement of the ocean mail steamship service of foreign countries.

JANUARY 30, 1878.—Referred to the Committee on the Post-Office and Post-Roads and ordered to be printed.

POST-OFFICE DEPARTMENT,
Washington, D. C., January 29, 1878.

SIR: I have the honor to transmit herewith, in compliance with the resolution of the House of Representatives of the 25th instant, a tabular statement of the ocean mail steamship services of foreign countries, compiled from official data in the Office of Foreign Mails of this department, which comprises all the information in the possession of this department relating to the organized ocean mail steamship services maintained by foreign governments.

I am, very respectfully, your obedient servant,

D. M. KEY,
Postmaster-General.

HON. SAMUEL J. RANDALL,
Speaker of the House of Representatives.

Abstract showing the arrangements of the several countries named therein for the maritime conveyance of their foreign mails.

[Compiled from official data in the Office of Foreign Mails, Post-Office Department.]

Countries.	Line of communication.	Contracts. Commenced—	Contracts. Terminate—	Frequency of service.	Payment.	Penalties for overtime.
Austria	Various lines. (Austro-Hungarian Lloyd Steam Navigation Company.)	....	....	....	4 florins, Austrian value, per marine league, for each voyage at full speed; 1 florin 15 kreuzer, Austrian value, for each ordinary voyage; but total subsidy cannot exceed 700,000 florins, Austrian value, per annum. 1 florin = $48\frac{3}{4}$ cents, 1 kreuzer = $4\frac{8}{10}$ mills.	
Belgium	Antwerp–Brazil and La Plata. (The Liverpool, Brazil and River Plata Steam Navigation Company, limited.)	Jan. 1, 1876	In 15 years.	Three departures a month outward and inward, but only fortnightly service exacted during the first two years.	250,000 francs per annum. (See Appendix A.) 1 franc = $19\frac{3}{10}$ cents.	See Appendix A.
	Antwerp–New York and Philadelphia, alternately. (Belgian-American Navigation Society, representing the International Navigation Company of Philadelphia.)	July 1, 1877	In 15 years, and contingently in 10 years.	Fortnightly till Dec. 31, 1878.	250,000 francs per annum	See Appendix B.
				Every 12 days, from Jan. 1, 1879, to June 30, 1879.	do	
				Three times a month from July 1, 1879.	375,000 francs per annum	
				If government and company agree as to necessity there may subsequently be a weekly service.	500,000 francs per annum	
	Antwerp–Chili and Peru. (German company "Kosmos.")	....	....	Touching at Antwerp the 19th of each month.	A sea-postage, per single rate, on the correspondence conveyed. The vessels of the company carrying the mails are also exempt from fees for pilotage, lights, and signals, both entering and leaving the port of Antwerp.	
Denmark	Copenhagen–Reykjavik (Iceland). (Forende Damskibselskab, Copenhagen).	....	....	Seven trips a year, between 1st of March and 30th of November.	40,000 kroner. 1 krone = 27 cents	
	By government steamer	....	....	Three trips a year, between 1st of March and 30th of November.	Excess of cost of service over receipts, 28,500 kroner.	
France	Corsica	Aug. 1, 1873	July 31, 1883	....	375,000 francs per annum; *i. e.*, francs 11.847 per marine league.	See Appendix C.
	Viz:					
	Marseilles–Bastia, direct	....	....	Weekly	....	
	Marseilles–Bastia via Nice	....	....	do	....	

Marseilles-Calvi, direct, and L'Ile Rousse, direct, alternately.			Every 15 days		
Marseilles-Ajaccio, with branch			Weekly		
service to Bonifacio, and					
Propiano alternately, and			Every 15 days		
Porto Torrès			Weekly		
(A. & L. Fraissinet & Co., Marseilles).					
Mediterranean	Oct. 1, 1851	July 22, 1888		4,382,263 francs per annum	See Appendix D.
Viz:					
Marseilles-Constantinople via the Piræus.			Fortnightly		
Marseilles-Constantinople via Smyrna.			do		
Marseilles-Alexandria			do		
Circular lines of Egypt and Syria, being a combination of regular trips of Marseilles-Smyrna, Smyrna-Alexandria, Alexandria-Marseilles.			do		
Brazil and La Plata—Bordeaux-Buenos Ayres, direct. (Compagnie des Messageries Maritimes, Paris.)	July 22, 1861	July 22, 1888	Monthly	(Included in "Mediterranean" service above).	See Appendix E.
United States — Havre - New York.	July 22, 1865	July 21, 1885	Fortnightly or weekly, according to the season.	3,644,000 francs per annum	See Appendix F.
Antilles and Mexico	July 22, 1865	July 21, 1885		6,314,605 francs per annum	Do.
San Nazaire-Colon			Monthly		
San Nazaire-Vera Cruz			do		
Fort de France-Cayenne			do		
Havre and Bordeaux-Colon			do		
(General Trans-Atlantic Company, Paris).					
Indo-China	July 22, 1864	July 21, 1888		8,573,024 francs per annum	See Appendix G.
Marseilles-Hong-Kong			Fortnightly		
Pointe de Galle-Calcutta			Every four weeks		
Singapore-Batavia			Fortnightly		
Hong-Kong-Shanghai			do		
Hong-Kong-Yokohama			do		
Aden-Réunion and Mauritius			Every four weeks		
(Compagnie des Messageries Maritimes, Paris).					
English channel—Calais-Dover (English companies: "South Eastern Railway" and "London, Chatham and Dover Railway," represented by the General Society for the Development of Commerce and Industry in France.)	Oct. 1, 1872	Sept. 30, 1884	Daily	100,000 francs per annum	See Appendix H.

Abstract showing the arrangements of the several countries named therein for the maritime conveyance of their foreign mails—Continued.

Countries.	Line of communication.	Contracts. Commenced—	Contracts. Terminate—	Frequency of service.	Payment.	Penalties for overtime.
Germany	Hamburg-New York			Weekly	$20\frac{5}{8}$ pfennigs (26 centimes) per 30 grammes for letters, and 40 pfennigs (50 centimes) per kilogramme for printed matter, &c.	
	Hamburg-St. Thomas			Fortnightly		
	Hamburg-Colon via St. Thomas. (Hamburg-American Packet Company.)			do		
	Hamburg-Lisbon			do	$20\frac{5}{8}$ pfennigs (26 centimes) per 30 grammes for letters; 40 pfennigs (50 centimes) per kilogramme for printed matter, &c.	
	Hamburg-Buenos Ayres via Lisbon, Bahia, Rio de Janeiro, Santos, and Montevideo. (Hamburg South American Packet Company.)			do	20 pfennigs (25 centimes) per single rate for letters; 60 pfennigs (75 centimes) per kilogramme for printed matter, &c.	
	Hamburg-Montevideo via Antwerp. ("Kosmos" Company.)			Monthly	20 pfennigs (25 centimes) per single rate for letters; 60 pfennigs (75 centimes) per kilogramme for printed matter, &c.	
	Hamburg-Callao via Antwerp, Montevideo, Valparaiso, Arica, and Mollendo. ("Kosmos" Company.)			Monthly	30 pfennigs ($37\frac{1}{2}$ centimes) per single rate for letters; 80 pfennigs (1 franc) per kilogramme for printed matter, &c.	
	Bremen-New York			Weekly	$20\frac{5}{8}$ pfennigs (26 centimes) per 30 grammes for letters; and 40 pfennigs (50 centimes) per kilogramme for printed matter, &c.	
	Bremen-Havana Bremen-New Orleans			Once or twice a month from September to May.		
	Bremen-Buenos Ayres via Lisbon, Bahia, Rio de Janeiro, and Montevideo. (North German Lloyd of Bremen.)			Monthly	20 pfennigs (25 centimes) per single rate for letters; 60 pfennigs (75 centimes) per kilogramme for printed matter, &c.	
	Kiel-Korsoer			Daily	Service at common expense of Germany and Denmark; Germany's share yearly about 180,000 marks. 1 mark = $.23\frac{82}{100}$ cents.	

	Stralsund–Malmö. (Rügen's Company, Stralsund.)			Three times a week from April to September.	15,000 marks per annum	
	Lubeck–Malmö via Copenhagen. (Holland Steamboat Company.)			Daily from April to September	12,000 marks per annum	
	Rostock–Nykjöping. (Stockholders' Company, Rostock.)			Three times a week from April to September.	9,000 marks per annum	
Great Britain	Dover–Calais. (South Eastern Railway Company and London, Chatham and Dover Railway Company.)	June 20, 1863	June 20, 1878	Daily	£6,000 per annum; also a premium of £5 per trip allowed for undertime. £1 sterling = $4.8665 +.	£5 deducted from accumulated premiums for undertime if 15 minutes too late.
	Brindisi–Bombay via Isthmus of Suez.	Aug. 15, '74	Jan. 31, 1880, if 24 months' previous notice has been given.	Weekly	£430,000 per annum	£100 for every 12 hours outward, and £200 for every 12 hours homeward.
	Brindisi–Pointe de Galle via Isthmus of Suez.			Fortnightly		£100 for every 12 hours outward.
	Brindisi–Calcutta via Isthmus of Suez.			......do		Do.
	Brindisi–Shanghai via Isthmus of Suez.			......do		Do.
	Southampton–Bombay via Isthmus of Suez.			Weekly		Do.
	Southampton–Pointe de Galle via Isthmus of Suez.			Fortnightly		Do.
	Bombay–Shanghai via Isthmus of Suez.			......do		Do.
	Hong-Kong–Yokohama via Isthmus of Suez. (Peninsular and Oriental Steam Navigation Company.)			......do		£100 for every 12 hours outward, and £200 for every 12 hours homeward.
	Halifax, Bermuda, and Saint Thomas (William Cunard, London, contractor.)	Jan. 1, 1868	Dec. 31, 1877	Every fourth week	£19,500 per annum	£60 for every 24 hours on round voyage, *i. e.*, Halifax to Saint Thomas and back.
	Southampton–Buenos Ayres. (Royal Mail Steam Packet Company.)	Sept. 1, 1876	On 6 months' notice.	Twice a month	Letters, 10½*d.* per ounce; newspapers, 3*d.* per pound; books and patterns, 5*d.* per pound. (Contract for outward voyages only.)	One-eighth part of ordinary payment for every 24 hours.
	West Indies. (Royal Mail Steam Packet Company.)	Jan. 1, 1875	Dec. 31, 1879, if 24 months' previous notice has been given.	......do	£86,750 per annum	£25 for every 24 hours.
	Panama and Valparaiso	Jan. 1, 1873	June 30, 1878	Four times a month	Letters, 1*s.* 6*d.* per ounce between Panama and Valparaiso; 1*s.* 3*d.* between Liverpool and Callao; newspapers, 3*d.* per pound; books and patterns, 5*d.* per pound. (Homeward mails from Callao landed at Bordeaux, on which only 1*s.* per ounce on letters is paid.)	One-eighth part of ordinary payment for every 24 hours.

Abstract showing the arrangements of the several countries named therein for the maritime conveyance of their foreign mails—Continued.

Countries.	Line of communication.	Contracts. Commenced—	Contracts. Terminate—	Frequency of service.	Payment.	Penalties for overtime.
Great Britain—Continued.	Brazil, River Plata, and Pacific. (Pacific Steam Navigation Company.)	Jan. 1, 1873	June 30, 1878	Fortnightly		
	Cape of Good Hope and Zanzibar. (Union Steamship Company, Southampton.)	Aug. 1, 1873	Feb. 8, 1881	Once every four weeks	£20,000 per annum	
	Aden and Zanzibar. (British India Steam Navigation Company.)	Dec. 6, 1872	Dec. 5, 1882. Earlier on certain conditions.	do	£10,000 per annum	
	Saint Kitts, Nevis, and Montserrat. (Frederick Slater Cassin, Antigua, contractor.)	Jan. 1, 1864	On 6 months' notice.	Four times a month	£490 per annum	
	Liverpool-Porto Cabello	Oct. 1, 1875	On 6 months' notice.	Monthly	Letters, 1s. 3d. per ounce; newspapers, 3d. per pound; books and patterns, 5d. per pound. (Less payment provided for in certain cases. Contract for outward voyages only).	One-eighth part of ordinary payment for every 24 hours.
	Liverpool-Tampico			do		
	Liverpool-Santa Martha (West India and Pacific Steamship Company, Liverpool.)			do		
	West Coast of Africa. (African Steamship Company, London, and British and African Steam Navigation Company, Glasgow.)			Weekly	Letters, a sum equal to amount of sea-postage; soldiers' and sailors' letters, ½d. each; newspapers, ½d. each; books and patterns, ½d. per pound.	
	Cape of Good Hope. (Union Steamship Company, Southampton; and Castle Packets Company, London.)	Oct. 1, 1876	Sept. 30, 1883, if 12 months' notice has been given.	do	Letters, sea and inland postage; newspapers, 1d. per 4 ounces; books and patterns, 3d. per 4 ounces.	£50 for first complete period of 12 hours beyond 27 or 28 days, and £4 3s. 4d. for every complete hour up to and including the third day of 24 hours, and then at the rate of £6 5s. per hour for every complete hour consumed on voyage beyond said third day.
Italy	Sardinia, Tuscan Archipelago, Corsica, &c.				1,795,296 francs per annum	
	Egypt and India				1,380,000 francs per annum	

Indo-China				500,128 francs per annum
Via:				
Marseilles-Tunis			Weekly	
Genoa-Cagliari (2 services)			do	
Genoa-Porto Torrés			do	
Leghorn-Porto Torrés			do	
Cagliari-Porto Torrés			do	
Cagliari-Naples			do	
Cagliari-Palermo			do	
Leghorn-Porto San Stefano			do	
Leghorn-Porto Ferrajo			do	
Genoa-Alexandria			do	
Genoa-Bombay			Monthly	
Genoa-Singapore			Quarterly	
Singapore-Batavia			do	
Genoa-Naples			Weekly	
Tunis-Sfax			do	
Tunis-Tripoli			do	
Porto Ferrajo-Piombino			Daily	
(R. Rubbatino & Co.)				3,735,424 francs per annum
Line between Venice and Alexandria, Egypt. (Peninsular and Oriental Company.)			Weekly	500,000 francs per annum
Genoa-Buenos Ayres. (G. B. Lavarello & Co.)			Month'y	10 centimes per single rate for letters; 5 centimes per 40 grams for printed matter.
Sicily and the Minor Islands, Malta, &c.				2,411,476 francs per annum
Turkey, Greece, Dalmatia, Syria, &c., viz:				1,675,128 francs per annum
Venice-Constantinople			Weekly	
Constantinople-Odessa			Fortnightly	
Palermo-Sira			Weekly	
Sira-Salonica			Fortnightly	
Sira-Smyrna			do	
Brindisi-Corfu			Weekly	
Palermo-Marseilles			do	
Naples-Palermo			Six trips a week	
Naples-Malta			Weekly	
Naples-Messina (A)			Two trips a week	
Naples-Messina (B and C)			Weekly	
Messina-Malta			do	
Palermo-Messina (2 services)			do	
Palermo-Tunis			do	
Palermo-Syracuse			do	
Messina-Lipari-Salina			Twice a week	
Palermo-Ustica			Fortnightly	
(J. & V. Florio & Co.)				4,086,604 francs per annum

Abstract showing the arrangements of the several countries named therein for the maritime conveyance of their foreign mails—Continued.

Countries.	Line of communication.	Contracts. Commenced—	Contracts. Terminate—	Frequency of service.	Payment.	Penalties for overtime.
Japan	Yokohama-Shanghai				250,000 yen	
	Yokohama-Tusanpo-Corea				Included in above	
	Japan-Loo Choo Islands (Mitsu Bishi Company.)				6,000 yen. 1 yen = $1	
Netherlands	Nieuwediep-Naples-Batavia. ("Nederland" Steam Navigation Company.)	Jan., 1877		Every three weeks	3,000 florins for each voyage to and from the Indies; i. e., 99,000 to 112,000 florins for 33 to 34 voyages per year. 1 florin = 40 cents.	
Portugal	Lisbon-Mozambique (Portuguese Eastern Africa) and Goa (Portuguese India). (British India Steam Navigation Company, limited.)			From Lisbon every four weeks; day not fixed.	150,000 francs per annum	
	Mozambique, Luelimane, Inhambane, and Lourenco, Marques (Portuguese Eastern Africa). (British India Steam Navigation Company, limited.)			From Mozambique every four weeks; day not fixed.	75,000 francs per annum	
	Lisbon and Madeira			The 16th of each month	225,000 francs per annum	
	Lisbon and the islands of San Miguel, Terceira, and Fayal (Azores).			The 1st of each month		
	Lisbon and the islands of Santa Maria, S. Miguel, Terceira, Graciosa, S. Jorge, Fayal, and Flores (Azores). (Ben Saüde & Co.)			The 15th of each month		
	Lisbon lines—Lagos, Portimao, Faro, Ilhao, Tavira, and Villa Real de Santo Antonio (coast of Portugal). (Alonzo Gomes.)			The 1st and 16th of each month	55,555 francs 55 centimes per annum.	
	Lisbon, Madeira, St. Vincent, and St. Phiago (Cape Verde), the islands of Prince and S. Tomé, Ambriz, Loanda, Benguella, and Mossamedes (Portuguese Western Africa). (Bailey & Leetham.)			The 15th of each month	The exclusive privilege of these voyages is the only subsidy.	

Russia	Service on Black, Azov, and Marmora Seas, Greek Archipelago, Adriatic and Mediterranean Seas, Atlantic Ocean, and on the North Seas as far as the ports of Great Britain and Belgium, viz:	....	....	....	1st. A fixed sum of 64,000 roubles per annum. 2d. A subsidy of 2 roubles 15½ kopecks for each nautical mile traversed, calculated for a maximum of 436 $\frac{114}{1000}$ miles.
	Kherson Line—Odessa-Kherson.	....	....	Daily (except Sunday) from May to October; 3 times a week during remaining period of open navigation.	[NOTE.—This general method of payment includes all the Russian lines given in this table. 1 rouble, 77$\frac{1}{10}$ cents. 1 kopeck, 7$\frac{7}{10}$ mills.]
	Dnieper Line—Kherson-Nicopol	....	....	Three times a week from opening of navigation to October; twice a week during remaining period of open navigation.	
	Nicolaieff Line—Odessa-Nicolaieff.	....	....	Three times a week.	
	Line of the Crimea—Odessa-Kertch—(summer service).	....	....	Weekly from 25th March to 26th April; twice a month from 26th April to 28th October.	
	Line of the Crimea—(winter service).	....	....	Weekly from 28th October to January, and from January to 25th March.	
	Line of the Caucasus—Odessa-Poti—(summer service).	....	....	Same as "Line of Crimea," above.	
	Line of the Caucasus—(winter service).	....	....	Do.	
	Line of the Sea of Azov—Kertch-Taganrog—(summer service).	....	....	Weekly from 28th April to 27th October.	
	Line of the Sea of Azov—(winter service).	....	....	Weekly from opening of navigation to 27th March, and from 31st October to close of navigation.	
	Line of Crimea—Azov—(summer service).	....	....	Weekly from 25th March to 28th October, between the ports of the Crimea and all the ports of the Sea of Azov. Twice a week from 26th April to 28th October, between the ports of the Crimea, Berdiansk, and Taganrog.	
	Line of the Crimea—Azov—Odessa-Taganrog.	....	....	Daily.	
	Line of Kouban—Kertch-Tifliskaia-Stanitza.	....	....	Weekly........	[For terms of payment see preceding page.]
	Line of Constantinople—Constantinople-Odessa.	....	....	Two departures a week.	
	Line of Alexandria—Constantinople-Alexandria.	....	....	Semi-monthly.	
	Line between Constantinople, Anatolia, and the Caucasus.	....	....	Weekly.	

Abstract showing the arrangements of the several countries named therein for the maritime conveyance of their foreign mails—Continued.

Countries.	Line of communication.	Contracts. Commenced—	Contracts. Terminate—	Frequency of service.	Payment.	Penalties for overtime.
Russia—Cont'd	Line of England—Odessa-London.	....	....	Three departures a month.		
	Bombay Line—Odessa-Bombay	....	....	Six voyages according to special itinerary, October, 1876–April, 1877.		
	China Line—Odessa-Shanghai	....	....	Two steamers leave the middle and end of February, to get the first harvest of tea, returning to Odessa about the middle of July.		
	("Russian Steam Navigation Company" performs the entire Russian service given in this table.)					

APPENDIX A.

Extracts from contract with the Liverpool, Brazil and River Plate Steam Navigation Company (limited), showing the conditions of the subsidy and the penalties imposed for delays, &c.

ARTICLE 12.

A. The government gives up to the company the total amount of the postal tax, accruing to the national treasury of Belgium, for the mails which it shall have conveyed by its packets, as well for the correspondence originating in or addressed to Belgium as for that coming from or addressed to foreign countries.

B. The tariff of rates to be collected, and the amount of which is granted to the company, forms but one whole, comprising: 1st, the sea-tax; 2d, the Belgian territorial tax; 3d, the Belgian transit taxes due by foreign offices.

C. Beginning with the date of putting into operation the service of three departures a month (provided for in the contract), the government will guarantee to the contractors a minimum of postal revenue of 250,000 francs per annum, during a period of six consecutive years, on condition that the company has adopted the Belgian flag.

D. This guarantee shall cease its effects: 1st, if the service three times a month has been interrupted; 2d, beginning with the date on which it shall be verified that the postal receipts given up to the profit of the company shall have reached, during two consecutive years, the sums guaranteed. In either case, it cannot again be established.

E. As soon as the proceeds shall exceed the minimum guaranteed, the administration shall retain to the profit of the treasury all sums exceeding that limit, even extending to the sums previously paid by the state.

ARTICLE 14.

A. The fees for pilotage, lights, and signals, collected by Belgium, both on arrival and departure of the mail-packets, as well as the taxes that may be paid by the company for Netherland pilotage, shall be reimbursed to the company at the expiration of each quarter, on production of the receipts for the sums paid therefor.

B. No one of these taxes shall be reimbursed, if the commander of the vessel shall not have made use of a pilot that he could procure.

ARTICLE 47.

Penalties.

Except in cases of force majeure, and so considered by Belgian laws:

A. In case of delay in the departure from Antwerp or Buenos Ayres after the hour fixed under the contract, a fine of 50 francs per hour of delay will be imposed. If delay is beyond twenty-four hours, this fine will be increased to 100 francs per hour for the whole duration of the delay, and if it is proved that it had for its cause either the tardy embarkation of merchandise, passengers, or mails (except in the case of delay for mails authorized under the contract), or the negligence or ill intention of the company, these fines may respectively be doubled.

Moreover, if the departure be delayed more than twenty-four hours, the agent of the government, and, in his default, the agents of the post-offices intrusting their mails to the packets of the contractors, in execution of the present agreement, may take, at the expense, risk, and peril of the latter, all the measures necessary to assure the transportation of said mails by the most rapid route and means.

B. For every delay beyond the time fixed under the contract for the duration of the voyages, a fine of 50 francs per hour will be imposed. This fine will be increased to 100 francs per hour for the whole duration of the delay, if it is prolonged beyond three times twenty-four hours. It is understood that a ship having arrived in the Flushing Roads six hours before the expiration of the time fixed for the duration of the voyage, and, by reason of fogs, ice, or lack of pilot, being prevented from regularly pursuing its voyage, shall be considered as having arrived in time in Antwerp Roads. It is also understood that a ship arriving twelve hours before the expiration of the time fixed for the duration of the voyage, at the mouth of the river La Plata, and on account of low water or quarantine, being prevented from going up the river to Buenos Ayres, shall be considered as having arrived in time, if the company has delivered the mails at destination within twenty-four hours.

C. For every delay in or call at a port in contravention of the stipulations of the contract, a fine of two thousand francs will be imposed, which will be increased to ten thousand francs in case mails, merchandise, or passengers have been embarked or disembarked.

D. For every obligatory call not made there will be a fine of ten thousand francs, except at Rio de Janeiro, when quarantine is imposed. But in this case the company is obliged to tranship the mails and passengers in order to send them to destination at

its expense, risk, and peril, by the first ship leaving Montevideo for Rio. If this obligation is not fulfilled the fine shall be applied.

F. For not replacing a vessel within the time prescribed in the contract, there will be a fine of five hundred francs per day of delay.

G. For direct non-execution of every injunction addressed to the contractors by the administration the commission of surveillance named by the minister of public works, or the agent of the government, in conformity with the clauses and conditions of the contract, there will be a fine of two hundred francs for each day of delay.

APPENDIX B.

Extracts from contract with Belgian-American Navigation Society, representing the "International Navigation Company of Philadelphia," showing the conditions of the subsidy, and the penalties imposed for delays, &c.

ARTICLE 10.

A. The government gives up to the contractors the total amount of the postal tax, accruing to the national treasury of Belgium, for the mails which they shall have conveyed by their packets, as well for the correspondence originating in or addressed to Belgium as for that coming from or addressed to foreign countries.

B. The tariff of rates to be collected, and the amount of which is granted to the contractors, forms but one whole, comprising: 1st, the sea-tax; 2d, the Belgian territorial tax; 3d, the Belgian transit taxes due by foreign offices.

C. The government guarantees to the contractors a minimum of postal proceeds fixed as follows:

1st. Beginning with the date of putting into operation the "every twelve days" service (provided for in the contract), two hundred and fifty thousand francs per annum.

2d. Beginning with the putting into operation of the "every ten days" service provided for in the contract, three hundred and seventy-five thousand francs per annum.

3d. Beginning with the eventual establishment of a weekly service, five hundred thousand francs per annum.

D. If the proceeds should exceed the maximum guaranteed, the administration would retain to the profit of the treasury all sums exceeding that limit, even extending to the amounts previously paid by the state.

ARTICLE 12.

A. The fees for pilotage, lights, and signals, collected by Belgium, both on arrival and departure of the mail-packets, as well as the taxes that may be paid by the company for Netherland pilotage, shall be reimbursed to the company at the expiration of each quarter, on production of the receipts for the sums paid therefor.

B. No one of these taxes shall be reimbursed if the commander of the vessel shall not have made use of a pilot that he could procure.

ARTICLE 45.

Penalties.

Except in cases of force majeure, and so considered by Belgian laws:

A. In case of delay in the departure from Antwerp, New York, or Philadelphia, after the hour fixed under the contract, a fine of fifty francs per hour of delay will be imposed. If the delay is beyond twenty-four hours, this fine will be increased to one hundred francs per hour for the whole duration of the delay, and if it is proved that it had for its cause, either the tardy embarkation of merchandise, passengers, or mails (except in the case of delay for mails authorized by contract), or the negligence or ill intention of the contractors, these fines may be respectively doubled.

Moreover, if the departure be delayed more than twenty-four hours, the agent of the government, and in his default the agents of the post-offices intrusting their mails to the packets of the contractors in execution of the present agreement, may, at the expense, risk, and peril of the latter, take all the measures necessary to assure the transportation of said mails by the most rapid route and means.

B. For every delay beyond the time fixed under the contract for the duration of the voyages, a fine of fifty francs per hour will be imposed. This fine will be increased to a hundred francs per hour for the whole duration of the delay, if it is prolonged beyond three times twenty-four hours.

C. For every delay in or call at a port in contravention of the stipulations of the

contract, except in the case of forced delay, a fine of two thousand francs will be imposed, which will be increased to ten thousand francs if mails, merchandise, or passengers have been embarked or disembarked.

D. For every obligatory call not made there will be a fine of ten thousand francs.

E. For not replacing a vessel within the time prescribed in the contract, a fine of five hundred francs per day of delay.

F. For direct non-execution of every injunction addressed to the contractors by the administration, the maritime commission named by the minister of public works, or the agent of the government, in conformity with the clause and conditions of the contract, a fine of two hundred francs for each day of delay.

APPENDIX C.

CORSICAN LINE.

Penalties.

Except in cases of force majeure duly verified, or when the packets have been temporarily detained by competent authority, infractions of the itinerary or other regulations for the service subject the contractors to the following penalties:

For every delay in the hour of departure from or arrival at the terminal points, a fine of fifty francs per hour or fraction of an hour. If the delay is beyond six consecutive hours, the fine may be increased to one hundred francs for each subsequent hour or fraction of an hour.

If proved that the delay was caused by the embarkation of passengers or merchandise, the fine will be one hundred francs per hour or fraction of an hour, and after six hours two hundred francs.

If the delay is more than twelve hours, the government agent at Marseilles or his deputies may take the necessary measures to assure the dispatch of the mails by another route, at the expense of the contractors.

Embarkation of merchandise between the time of delivery of the mails on board and the normal hour of departure, will be punished by a fine of twenty-five francs for the first offense, and fifty francs if repeated.

Negligence in the service of receiving, delivering, or caring for the mails and movable boxes (for late letters) on board, will be punished by a fine of twenty-five to one hundred francs.

For not posting in the places prescribed the notices furnished by the postal administration relative to the fraudulent transportation of correspondence, the contractor will be liable to a fine, the amount of which shall not be less than twenty-five francs nor exceed one thousand francs.

Unjustified delays or the embarkation or disembarkation of passengers or merchandise during justified delays in the ports at which the packets may be obliged to touch, will be punished by a fine of five hundred francs for the first offense, one thousand francs for the second, and if a third occurs during the year, the minister of finance may annul the contract.

The penalties provided in the last paragraph will also apply in the case of formal disobedience of the orders of the government agent, his delegates, or the permanent commission of surveillance.

The non-execution of a voyage or even of a single trip, if the fault of the contractor, will be punished by a deduction of a part of the subsidy proportioned to the number of marine leagues not traversed, and this without prejudice to a fine for delay calculated for twelve full hours.

Every trip undertaken in accordance with the itinerary, but interrupted by an accident beyond the power of the contractor to prevent, shall be considered as accomplished, and no part of the subsidy shall be deducted therefor. But if the vessel returns to port, and the mails are intrusted to another vessel, French or foreign, the expenses of the transportation shall be paid by the contractor. So, also, if the mails are transshipped at sea and sent to destination by another vessel.

If the contractor frequently exposes himself to penalties, and it becomes evident that the contract is executed with habitual negligence or bad faith, the minister of finance may annul the contract without indemnity.

If, for any other cause than war, the contractor should suspend or abandon the service, the administration will continue it, employing the vessels belonging to the contractor used by him in the service, the expenses and risks thereof being at the charge of the contractor, while he can claim no part of the subsidy, nor any indemnity whatever.

If the contractor does not commence the service on the date stipulated, it will be executed at his expense, with the means that the government is able to procure.

After a maximum delay of two months, the contract will be forfeited, and a new award made.

APPENDIX D.

MEDITERRANEAN LINE.

Penalties.

Except in cases of force majeure duly verified, or when the vessels have been temporarily detained by competent authority, infractions of the regulations for the days and hours of departure and arrival, and the length of voyage, subject the company to a fine of fifty francs per hour of delay.

For unjustified delay beyond six consecutive hours, the fine may be increased to one hundred francs per hour.

If proved that delay was caused by tardy embarkation of merchandise, the fine will be two hundred francs.

After twelve hours, the postal agent, in concert with the local authorities as far as possible, shall take measures to assure the dispatch of the mails, and the expenses resulting therefrom will be at the charge of the company.

In case of delay at a port not justified by circumstances of force majeure, the fine will be for first offense one thousand francs; for second two thousand francs, and for third may be increased to five thousand francs.

The provisions of the last paragraph also apply, if the company or its agents have, except in cases of force majeure, embarked or disembarked passengers or merchandise in ports of delay other than those designated in the contract.

If the delay in departure exceeds twenty-four hours, the government agent at Marseilles, or the postal agent at Constantinople and Alexandria, by accord with the authorities, shall have the right to dispatch another vessel, either government or merchant, at the expense of the company.

In case of loss of a vessel, if it is not replaced within the time specified in the contract, a fine of one hundred and fifty francs per day of delay will be imposed.

For not commencing the service at the time prescribed in the contract, there will be a fine of five hundred francs per day of delay.

If in any case other than that of war or force majeure, the company should suspend or abandon the service, the administration will, by the advice of experts, take possession of the vessels with all their material, &c., and a commission, appointed by the minister of finance, will determine the amount of fine to which the company will be subjected, which amount may be as high as a million francs.

APPENDIX E.

BRAZIL AND LA PLATA LINE.

Penalties.

For every delay in departure from the terminal and intermediate points, except in cases of force majeure duly verified, or when the vessels have been temporarily detained by competent authority, a fine of fifty francs per hour of delay will be imposed.

Beyond twelve consecutive hours of unjustified delay, the fine will be increased to one hundred francs per hour.

If it is proved that the delay was caused by the tardy embarkation of merchandise, these fines will be doubled.

If the delay in departure should exceed twenty-four hours, the government agent, or, in his default, the postal agents, shall, in concert with the local authorities, the company included, take the necessary steps to assure the dispatch of the mails at the expense of the company.

If, for any cause, the mails can only be sent by the vessel making the next regular departure after the one not made, the number of leagues not traversed under these conditions shall give rise to a proportionate reduction of the subsidy.

If the time prescribed for the duration of the voyage is exceeded by a fortieth, 4 per cent. of the subsidy will be retained for the first fortieth, 8 per cent. for the second, 12 per cent. for the third, and so on; 4 per cent. for each fortieth.

For delay in a port, not justified by circumstances of force majeure, there will be a fine of one thousand francs for the first offense, two thousand francs for the second, and for the third the fine may be increased to five thousand francs; and in these cases, if merchandise or passengers have been embarked or disembarked, the fines will be doubled.

In case of the loss of a vessel, if it is not replaced within the time prescribed in the contract, there will be a fine of three hundred francs for each day of delay, if the vessel to be replaced is of four hundred and fifty horse-power, and of five hundred francs if it is of two hundred horse-power.

If the service is not commenced at the time prescribed in the contract, one hundred and fifty francs per day of delay will be retained from the amounts due the company.

APPENDIX F.

LINES OF THE UNITED STATES, ANTILLES, AND MEXICO.

Penalties.

Except in cases of force majeure duly proved, or when the packets are temporarily detained by competent authority, every delay in the departure from the terminal or intermediate points will subject the company to a fine of fifty francs per hour.

Beyond twelve consecutive hours of unjustified delay the fine will be increased to one hundred francs per hour.

If it is proved that the delay was caused by the tardy embarkation of merchandise these fines will be doubled.

If the delay exceeds twenty-four hours, the government agent, or in his default the postal agents, shall, in concert with the local authorities—the company included—take the necessary measures to assure the dispatch of the mails, and all the expenses resulting therefrom shall be at the charge of the company.

If, for any cause whatever, the mails can only be forwarded by the vessel making the next regular departure after the one not made, the number of leagues not traversed under these conditions shall give rise to a proportionate reduction of the subsidy.

If the time fixed by the contract for the duration of the voyages is exceeded by a fortieth, 4 per cent. will be retained from the subsidy for the first fortieth, 8 per cent. for the second, 12 per cent. for the third, and so on; 4 per cent. for each fortieth.

In case of delay in a port not justified by circumstances of force majeure, the fine will be one thousand francs for the first offense, two thousand francs for the second, and for the third it may be increased to five thousand francs; and in these cases, if merchandise or passengers have been embarked or disembarked, the fines will be doubled.

In case of the loss of a vessel, if it is not replaced within the time prescribed in the contract, the company will be liable to a fine of five hundred francs for each day of delay, if the vessel to be replaced is of seven hundred and fifty horse-power; of four hundred francs if it is of six hundred and fifty horse-power; and of one hundred and fifty francs if it is of two hundred horse-power.

If the company does not commence the service at the time prescribed in the contract, one hundred and fifty francs for each day of delay will be retained from the amounts due the company.

APPENDIX G.

INDO-CHINA LINE.

Penalties.

For every delay in departure from the terminal or intermediate points, except under circumstances of force majeure duly verified, or when the vessels are temporarily detained by competent authority, the company is liable to a fine of fifty francs per hour of delay.

Beyond twelve consecutive hours of unjustified delay the fine will be increased to one hundred francs per hour.

If it is proved that the delay was caused by the tardy embarkation of merchandise these fines will be doubled.

If the delay in the departure exceeds twenty-four hours, the government agent or postal agent shall take the necessary measures, in concert with the local authorities—the company included—to assure the dispatch of the mails, and the expenses resulting therefrom will be at the charge of the company.

If, for any cause, the mails can only be sent by the vessel making the next regular departure after the one not made, the number of leagues not traversed under these conditions shall give rise to a proportionate reduction of the subsidy.

In case of delay at a port, not justified by circumstances of force majeure, the fine will be for the first offense one thousand francs; for the second, two thousand francs; and for the third it may be five thousand francs; and in these cases, if merchandise or passengers have been embarked or disembarked, the fines will be doubled.

In case of the loss of a vessel, if it is not replaced within the time prescribed in the contract, there will be a fine of three hundred francs for each day of delay, if the vessel to be replaced is of four hundred and fifty horse-power, and of one hundred and fifty francs if it is of less power.

If the service is not commenced at the time prescribed in the contract, a fine of one hundred and fifty francs per day of delay will be retained from the amounts due the company.

Appendix H.

LINE OF DOVER—CALAIS.

Penalties.

Except in cases of force majeure duly verified, or when the vessels have been temporarily detained by competent authority, infractions of the regulations concerning the hours of departure and arrival will subject the company to a fine of one hundred francs per hour of delay for the first six hours.

If it is proved that the delay was caused by the tardy embarkation of passengers or merchandise, the fine will be two hundred francs per hour.

Beyond six consecutive hours of unjustified delay, the fine may be increased to one thousand francs per hour of delay.

Independently of these fines, after twelve hours of delay, the government agent at Calais and the postal agent at Dover may dispatch another vessel, either government or merchant, at the expense and risk of the company.

STEAM-BOILER EXPLOSIONS.

MESSAGE

FROM THE

PRESIDENT OF THE UNITED STATES,

TRANSMITTING

The report of the commission appointed under the act of Congress approved March 3, 1873, relative to the causes of steam-boiler explosions.

FEBRUARY 4, 1878.—Referred to the Committee on Commerce and ordered to be printed.

To the Senate and House of Representatives:

The commission appointed under the act of Congress approved March 3, 1873, entitled "An act to authorize inquiries into the causes of steam-boiler explosions," has addressed a report of progress made to date thereof to the Secretaries of the Treasury and Navy Departments, which has been transmitted to me by these officers. The commission also present a copy of a report dated February 27, 1877, which they say "was mislaid, and did not reach the President."

These reports are respectfully submitted for the information of Congress.

R. B. HAYES.

EXECUTIVE MANSION, *February* 4, 1878.

TREASURY DEPARTMENT,
OFFICE OF THE SECRETARY,
January 22, 1878.

SIR: We have the honor to transmit herewith, for the information of Congress, a report of progress made to date thereof by the commission appointed under the act of Congress of March 3, 1873, entitled "An act to authorize inquiries into the causes of steam-boiler explosions."

Very respectfully, your obedient servant,

JOHN SHERMAN,
Secretary of the Treasury.
R. W. THOMPSON,
Secretary of the Navy.

The PRESIDENT.

BOSTON, MASS., *December* 31, 1877.

GENTLEMEN: The commission appointed under the act of Congress approved March 3, 1873, entitled "An act to authorize inquiries into the causes of steam-boiler explosions," desire respectfully to report progress, and to call your attention to the report made by the commission February 27, 1877, a copy of which is herewith presented, which report, it now appears, was mislaid, and did not reach the President.

The work of so far completing the electrical instruments as to enable the commission to resume operations in the field proved to be greater than was supposed at the time of making the above report, and they were only just ready for the final tests by the commission at the time of the decision of the honorable Secretary of the Treasury that the balance of the appropriation must be covered into the Treasury. The instruments were then put in as good condition, to stand unused, as possible, in the temporary structures erected for their adjustment in Cambridge, Mass.

The watchmen in charge of the experimental grounds, boilers, tools, and apparatus at Sandy Hook and at Pittsburgh were notified of the decision, but, at the persuasion of the commission, they have consented to remain, and still remain, in charge and care of the government property, trusting that some proper mode may be arrived at by which they may hereafter be paid for their services.

At the time of this decision of the honorable Secretary of the Treasury the indebtedness of the commission for materials received, for labor performed, and for rent of grounds at Cambridge and at Pittsburgh, for which contracts were made in reliance upon the use of the balance of the appropriation, was, aside from the expenses and services of the commissioners, very nearly $1,700, most of which is due parties who are in great need of the money.

The watchmen who have remained in charge of the property at Sandy Hook and at Pittsburgh should also be paid for their services from the 1st of July, 1877, to the present time, the sum of $600, and they should also be paid for their continued services in the care of the property.

The commission most respectfully and earnestly request the reappropriation of the balance, $4,064.96, covered into the Treasury, at as early a day as is practicable; and, also, in order that all needed preparations may be made for the successful resumption and prosecution of the work in the field, as soon as the weather is suitable, an additional appropriation of $30,000.

The commission will now be enabled by the use of the electrical instruments to know, at a safe distance from the boiler being experimented with, the exact condition of the water within it, as to its close contact with all parts of the heated surfaces, the exact temperature of the water and of the steam in all parts of the boiler, and also, by the use of the telephone, as recently modified by the commission to adapt it to the purpose, to hear, at this safe distance, the sounds made by alteration of form, and by the slipping or the breaking of the stays, or of the plates of the boiler.

The commission desire to say, in conclusion, that the examination and study of cases of explosion of working-boilers, since the report of February 27, 1877, and the re-examination of results of the experiments already made by the commission, all tend to show that we have

yet very much to learn in relation to the causes of steam-boiler explosions.

All of which is respectfully submitted.

JOHN D. RUNKLE.
CHAS. W. COPELAND.
J. R. ROBINSON.
I. V. HOLMES.

Hon. JOHN SHERMAN,
Secretary of the Treasury.
Hon. R. W. THOMPSON,
Secretary of the Navy.

BOSTON, MASS., *February* 27, 1877.

GENTLEMEN: The commission appointed under the act of Congress approved March 3, 1873, entitled "An act to authorize inquiries into the causes of steam-boiler explosions," desire respectfully to report that the electrical instruments upon which the commission has for over two years been engaged are now so far perfected that it is confidently believed that they will be ready for work in the field as soon as the weather is suitable.

The commission also desire to give more fully than has yet been done the reasons for undertaking to devise these instruments.

As is shown by the report made by the commission November 25, 1873, the instruments used up to that time had proved unreliable.

All the instruments that gave the most promise were then procured, not only at home, but from abroad, but it was still found impossible with them to obtain the desired knowledge of conditions within the boiler. In order to a more perfect understanding of the matter, but without going into it in detail, which will be done in the final report, it appears advisable that something should be said in relation to two of the most important conditions connected with these investigations; the first of which is, the condition of the water within the boiler, as to its contact with the surfaces exposed to the action of the fire, whether it is in close contact or otherwise; and the second is, the condition of the water as to its temperature, whether it has the temperature due the pressure, or otherwise.

It has long been known, from the experiments of Leidenfrost, Klaproth, and others, that when metallic surfaces are raised to certain elevated temperatures water will not remain in close contact with them, the contact being prevented by the action of the heat; Professor Tyndall says, "by the recoil of the molecular projectiles discharged" from the water next the heated surfaces.

The committee of the Franklin Institute found that when iron surfaces, like the interior of a steam-boiler, were raised to a temperature of about 400° Fahrenheit, the repulsion of the water was perfect. The experiments of this committee were made with small quantities of water and at atmospheric pressure, and it was supposed that pressure would tend to raise the temperature of perfect repulsion.

Experiments made since the report of this committee tend to show that pressure alone does not raise the temperature of perfect repulsion, but that the matter is governed largely by the strength of the circulation of the water within the boiler.

In relation to the second of the important conditions, that of the temperature of the water within the boiler, it is known from the experiments of Magnus, Donny, Dufour, and others, that water may be raised

to temperatures much above that due the pressure without boiling, and that when ebullition commences under these circumstances the excess of heat above that due the pressure is given off explosively.

It has been supposed by many that the temperature of water could not be raised within a steam-boiler because of the presence of solid matter, but the experiments of Dufour tend to show that solid matter, when present, soon parts with its air, so that it does not prevent the abnormal heating of the water.

It is believed by investigators whose opinions are certainly entitled to great weight that these conditions of the water are the causes of a large proportion of all the explosions that occur.

In relation to the first supposed cause, Professor Tyndall says: "We are more ignorant of these things than we ought to be. Experimental science has brought a series of true causes to light which may produce these terrible catastrophes, but practical science has not yet determined the extent to which they actually come into operation."

And in relation to the second supposed cause of explosions, after calling attention to the great number that have occurred, after boilers have "remained for a time quiescent," and given reason for supposing that they were caused by the overheating of the water contained in them, Professor Tyndall says: "I do not say that this *is* the case; but who can say that it is *not* the case. We have been dealing throughout with a real agency, which is certainly competent, if its power be invoked, to produce the most terrible effects."

It is clear, in view of these things, that experiments for learning the causes of steam-boiler explosions without instruments to show whether or not all parts of the boiler exposed to the action of the fire are in close contact with the water within the boiler, or without instruments to show the temperature of the water within the boiler, cannot be conclusive.

The experiments with the western steamboat boiler at Pittsburgh, in 1873, an account of which is given in report of November 25, 1873, was, however, of great value, as showing the weakness of the flues of those boilers, as compared with their shells, upon the calculated strength of which the working-pressure allowed was based, and upon the supposition that the flues were of equal strength; for although the instrument used proved so defective that there was much question, even, as to the pressure of steam at which the flues yielded, there was so much water in the boiler that it was certain that the upper parts of the flues were covered, so that the fact that the flues were collapsed while the shell, which must have been subjected to the same forces, was entirely uninjured, was conclusive as to the weakness of the flues, whatever was the cause of their yielding. It is *probable* that these flues were collapsed by a gradually increasing pressure of about 350 pounds, and without any abnormal action whatever, but it is not possible to *know* that this, in point of fact, was the case.

These conditions, and the additional one that many of the experiments must be conducted at temperatures much above the supposed temperatures of perfect repulsion, led the commission to decide to make no more experiments with the large boilers till suitable instruments could be procured. And while it is much to be regretted that this has taken so much time, and has been attended with so great expense, it is certain that all the information gained from the preliminary experiments, and from the study of the cases of explosion of working-boilers during the two years since that time, has tended to show, not only the great need of investigation in relation to the causes of explosion, but the wisdom of the decision in relation to the instruments, and to make it clearer that

the information contemplated in the act of Congress under which the commission was created cannot be obtained by the bursting of any number of steam-boilers, nor by the making of any number of experiments without such instruments. All of which is respectfully submitted.

JOHN D. RUNKLE.
CHAS. W. COPELAND.
ISAAC V. HOLMES.
J. R. ROBINSON.

Hon. LOT M. MORRILL,
Secretary of the Treasury.
Hon. GEO. M. ROBESON,
Secretary of the Navy.

HARBOR OF CINCINNATI.

LETTER

FROM

THE SECRETARY OF WAR,

TRANSMITTING

A report of the engineer concerning the best method of protecting the harbor of Cincinnati from ice.

JANUARY 23, 1878.—Referred to the Committee on Commerce.
FEBRUARY 5, 1878.—Recommitted to the Committee on Commerce and ordered to be printed.

WAR DEPARTMENT,
Washington City, January 22, 1878.

The Secretary of War has the honor to transmit to the House of Representatives, in compliance with the resolution of the House dated March 2, 1877, a report, with accompanying map, by Maj. W. E. Merrill, Corps of Engineers, on the best methods, by harbors of refuge or otherwise, of protecting the river-commerce of Cincinnati from floes of ice in the Ohio.

GEO. W. McCRARY,
Secretary of War.

The SPEAKER *of the House of Representatives.*

OFFICE OF THE CHIEF OF ENGINEERS,
Washington, D. C., January 21, 1878.

SIR: To enable the honorable the Secretary of War to comply with the requirements of the following resolution of the House of Representatives of March 2, 1877—

That the Secretary of War be requested to report to Congress on the best methods, by harbors of refuge or otherwise, of protecting the river-commerce of Cincinnati from floes of ice in the Ohio—

I beg leave to submit the inclosed copy of a report on the subject, with accompanying map, by Maj. William E. Merrill, Corps of Engineers, to whom the requisite surveys and examinations were intrusted. The report is full and as complete as the limited means at his dis-

posal would allow, and will doubtless afford all of the information that may be necessary to a proper understanding of the questions involved.

The resolution of the House of Representatives is herewith respectfully returned.

Very respectfully, your obedient servant,

A. A. HUMPHREYS,
Brigadier-General and Chief of Engineers.

Hon. GEO. W. MCCRARY,
Secretary of War.

PROTECTION OF THE COMMERCE OF CINCINNATI FROM DAMAGE BY ICE-FLOODS IN THE OHIO RIVER.

UNITED STATES ENGINEER OFFICE,
Cincinnati, Ohio, December 28, 1877.

GENERAL: I have the honor to submit the following report on the best means of protecting the commerce of Cincinnati from damage by ice-floods in the Ohio River. This report is made in accordance with a resolution which passed the House of Representatives March 2, 1877, and which reads as follows:

Resolved, That the Secretary of War be requested to report to Congress on the best methods, by harbors of refuge or otherwise, of protecting the river-commerce of Cincinnati from floes of ice in the Ohio.

HISTORY OF THE ICE-FLOOD OF 1876–'77.

Before discussing details of protection from ice-floods, it seems proper to give a history of the break-up of last winter, which was an unusually destructive one, and was doubtless the direct cause of the passage of the resolution in question, and also of two previous resolutions on the same subject, which will be mentioned further on in the report.

The first obstruction by ice during the winter of 1876–'77 occurred on the 8th of December, on which day the thermometer fell from 34 degrees at 4 p. m. to zero at midnight, notwithstanding which a few steamboats left port. On Saturday, the 9th, the weather continued cold, and the ice became so heavy that the underwriters would assume no further risks, and ordered all boats into winter-quarters. During the next week a few trips were made between Cincinnati and Huntington, but, owing to ice gorges below Cincinnati, only one or two boats left for the South, and none of them succeeded in getting through to Louisville. A second spell of very cold weather began on the 16th of December, and entirely suspended navigation for the whole length of the river.

At the Cincinnati Southern Railway bridge, which crosses the Ohio near the lower end of the city, the Keystone Bridge Company had just completed the scaffolding for the main-channel span, and had notified the public that this space was closed to navigation, by an advertisement dated December 9, the very day that the cold wave arrived. It was on this day, also, that a strong up-stream wind dislodged some of the floating booms thrown out to protect the trestling, and left it unsupported to resist the whole weight of moving ice. As this trestling obstructed a width of upward of 500 feet in the middle of the river, it was to be expected that the ice would first gorge here. The gorge occurred at noon of the 11th, and at 4.45 p. m. had become so heavy that the trestle-work gave way, and all of the bents except one or two on the north

side were carried off. No iron-work of the superstructure had been put in place, and therefore the loss was confined to the timber false-works; it was estimated at $10,000, not including the damage caused by the delay in the completion of the bridge. The formation and movement of this gorge sunk several coal-barges, and occasioned a loss of $5,000 at the coal-landings between Central avenue and the site of the bridge. No other damage was reported in the vicinity of Cincinnati while the river was closing up. Some losses were sustained at points above and below the city, but in all cases they were quite small.

The weather continued cold, and the river remained low, so that on the 26th of December pedestrians and teams were crossing the Ohio on the ice, not only at Cincinnati, but as far south as Evansville. The characteristic feature of the winter was a month of continued low temperature from December 9 to about January 9, giving on the Ohio itself a bountiful crop of clear ice, which, in some places, was said to average 14 inches in thickness.

There are no safe ice-harbors at or near Cincinnati, and most of the steamboats in port were, as usual, crowded along the public landing, between the Newport ferry and the suspension-bridge. The danger to these boats from any movement of ice was early apparent, for they were so tightly frozen in that any movement of the ice-field would have inevitably carried them along with it. In order to release them from the main body of ice, the underwriters, at an expense of $250, cut a channel, just outside the boats, from the foot of Central avenue up to the foot of Sycamore street, which was afterward continued by the Pomeroy Packet Company up to Newport-Ferry Landing, thus leaving a narrow strip of open water outside of all the boats at the landing, and disengaging them from the main ice-field. This work was completed by the 29th of December, and the strong current kept the channel open for the rest of the winter.

Meanwhile, in the lower part of the harbor, the Fifth-street ferry-boat and the tow-boat Kate Waters had kept open the line of the ferry, and a space extending up-stream several hundred feet.

On the 5th of January a narrow channel was cut by hand from the wharf-boat of the Louisville Mail Line immediately below the suspension-bridge across to the coal-landing on the Kentucky shore. During the next day the field of ice below this cut, and above the foot of Fifth street, moved down some 300 feet and then held fast on the point opposite Mueller's stone-yard, without doing any particular damage. This movement left a small section of open river below the suspension-bridge, and contracted, but did not close, the opening near the foot of Fifth street. Taking advantage of the new situation, one of the Champion tow-boats, which lay in the mouth of the Licking, attempted to clear out the channel above the suspension-bridge and opposite the public landing. The ice, however, proved so heavy that she succeeded in getting only a short distance from the shore, and accomplished no useful result.

The cold term was followed by heavy rains on the northwestern slope of the Allegheny Mountains, which raised all the streams coming in from West Virginia and Kentucky, and caused a rise in the Ohio that forced out the heavy ice before it had begun to weaken. A break-up under such conditions is, of course, much more dangerous to property than one occurring after the ice has become gradually rotted by mild weather, and is, therefore, too soft to do any injury when put in motion. It is a rare thing for ice to attain such strength as it did last winter, and it is very seldom put in motion by so great a flood. The conditions were, therefore, favorable for heavy losses.

The rise that started the ice began in the bend of the Ohio near the

mouths of the Kanawha and Big Sandy, and it gradually forced its way southward, the ice at each point holding the flood back until broken up by its irresistible pressure. On the 9th of January there was a movement at Ironton and Portsmouth, which sunk and carried away coal-boats and did much damage. The first serious movement at Cincinnati took place on the 12th. At Louisville it began on the 14th, at Evansville on the 15th, and at Shawneetown on the 16th. While this was going on in the middle and lower Ohio, a similar disastrous flood was pouring down the Monongahela and its tributary, the Youghiogheny.

Owing to still water in the pools of the Monongahela slackwater, heavier ice forms in this river than in the Ohio, but as this ice has to pass over the dams, it generally reaches Pittsburgh so broken up as to be harmless to navigation. In the exceptional break-up of last winter the high water not only carried out the Monongahela ice, while still retaining nearly its maximum strength, but it took along with it great numbers of empty and loaded coal-barges, which were lying in the harbors and at the coal tipples in the several pools. This whole mass went together over the dams and passed Pittsburgh on the top of the flood. It was, of course, almost impossible to hold coal-barges or steamboats against such a pressure. Eight steamboats were sunk and several others considerably damaged out of the seventy that were reported as wintering in the vicinity of Pittsburgh. The papers at the time reported that one hundred and thirty-two barges, flats, and boat-houses passed out of the Monongahela between 6.15 a. m. and 7 p. m. of January 14. During daylight of the same day one hundred and fifty coal-barges were reported as being carried along in the ice past Rochester, a town on the Ohio, 26 miles below Pittsburgh. The total loss from this ice-flood to the Pittsburgh navigation interests was estimated at the time at $1,500,000, which, however, is undoubtedly considerably in excess of the true loss. There was considerable loss of coal and coal-barges between Pittsburgh and Cincinnati, but comparatively little below the latter point.

The movement of ice at Cincinnati commenced at 9 a. m. of Friday, January 12, when the ice-field in front of the public landing broke away from the Newport and Cincinnati bridge, and moved down 350 feet, closing up the opening below the suspension-bridge, and sinking the steamer Calumet, which lay at the head of the line of boats, extending in close contact from Lawrence street to Vine. The harbor-ice moved as one piece, and owing perhaps to the channel cut outside of the boats for their protection, this heavy field got sufficient momentum toward the Ohio shore to crush in the Calumet, the first object that seriously opposed it. After moving a few hundred feet the ice was checked by that below and the movement stopped. At 11 p. m. on the same evening, a second movement of this ice-field occurred which sunk the steamer Andes, lying at the foot of Main street. Both the Calumet and the Andes were sunk by the ice that formed in the harbor before it had moved a thousand feet. An early effort was made by the Champion No. 8, to cut her way across from the Licking to pump out and raise the Calumet, but the ice was so heavy that she was unable to break through it. On Sunday morning, January 14, the river was open directly in front of the city, but gorged above at the marine ways, and below at Cullom's. At 11.40 a. m. these gorges broke, and as the river was rising rapidly no new gorge could form, and no further damage occurred. Navigation was resumed on the 18th of January, after an ice-blockade of forty days.

Besides the steamboats at the public landing and immediately below the suspension-bridge, there were four at the mouth of the Licking,

and five along the right bank below the marine railway and under the lee of the floating ice-breaker thrown out to protect the dry docks. All of these boats escaped injury. The total number of steamboats in port, including three on the ways at Covington, was 37; of these 7 were sunk or carried away, 3 of them, however, being small pleasure-boats, or steam-launches, valued at $1,000 each.

The amount of coal afloat was 220 barges, of which 8 were partly unloaded. There were also held in port 407 empty coal-barges, which were distributed along both shores from the mouth of the Little Miami to Sedamsville, and were tied up in fleets wherever there was any hope of protection from the ice.

Owing to the want of a tow-boat that could break through the harbor-ice, many of the empty barges were necessarily left in places where there was small probability that they could escape in case of a bad break-up. The heaviest fleets of loaded barges were at Coal Haven (a point on the left bank of the river nearly opposite the mouth of the Little Miami), at the Queen City elevator, and on the left shore at Ludlow, below the Southern Railway bridge. The greatest loss occurred at Waters's Landing, the lowest landing at Coal Haven. The number of loaded coal-barges lost was 71; the number of empty barges cut down or carried away was 175.

The loss on steamboats and wharf-boats at Cincinnati amounted to $73,650, and that on coal, coal-barges, coal-flats and floats to $202,895; making a total loss of $276,545. These figures have been obtained by personal investigation into each loss, and are believed to be substantially correct. Besides getting the actual value of property lost, I have had both sides of the river from the Little Miami to Sedamsville carefully canvassed to ascertain the number and position of boats at each landing when the ice moved, and which of them were sunk or carried away. Several months, however, had elapsed since the ice-flood, and there was much difficulty in getting the facts required. Discrepancies between the statements made by the owners of coal and by the foremen in charge of the flats could not always be reconciled, but the results obtained are thought to be quite accurate in the majority of cases, and approximately correct in the others.

Accompanying this report is a map of the harbor of Cincinnati, which shows the position and kind of each boat in the harbor on the 12th day of January, when the ice commenced moving. To make the information embodied in this map more apparent to the eye, all steamboats and barges that were sunk or carried away are colored red; loaded barges are shaded in black; empty ones are indicated only in outline.

Some barges that were carried away were recovered uninjured, but it was quite impossible to ascertain whence they started, and therefore no attempt has been made on the map to distinguish between those that were totally destroyed and those that were carried away and afterward recovered. Numbers of the latter floated out into the Mississippi before they were captured, and the expense of salvage and of bringing back such barges was quite heavy.

The information contained in the map is consolidated in the following table, the total loss sustained at each landing being summed up. Owners of coal-barges could often give their total loss of empty barges, but could not indicate the landings at which they lay; on the other hand, owners of landings could tell the number of barges carried away, but oftentimes did not know how many of them were recovered. The loss in empty barges, therefore, although nearly correct in the aggregate, has probably some errors in detail which could not be avoided.

Table of coal-barges, coal-flats, and similar craft in the harbor of Cincinnati during the ice-blockade of 1876–'77, giving the landings at which they lay, and the number and value of those cut down or carried away at the breaking up of the ice.

Bank.	Name of landing.	AT LANDING.					LOST.					Estimated loss.
		Coal-barges.			Flats, &c.		Coal-barges.			Flats, &c.		
		Loaded.	Partly unloaded.	Empty.	Loaded.	Empty.	Loaded.	Partly unloaded.	Empty.	Loaded.	Empty.	
Left	Brown's, upper	17					3					$5,850
Do	Stewart's	24		22			3		4			7,375
Do	Brown's, lower	13		7	1		1					1,470
Do	Waters's	36		9			26		4			48,600
Right	Kellogg's	7	2		1	4	7	2		1	4	12,500
Do		4		3		2	4		3		1	7,000
Left				3								
Right	Queen City Elevator	34	1	12		4	3	1	4		4	16,800
Do	Gardner's	1		4		1						
Left	Wolf's Rolling Mill		2			1		2				1,500
Right	Keystone Elevator			9		2			3		1	500
Do	Dodsworth's	3		6		3						200
Left	Williamson's			1		1			1			
Do	Gordon's			1		1			1		1	250
Do	Newport Barracks			5								
Do	Licking River	9		48	1	23	1		6	1		2,000
Do	Shinkle's	5		10		2	1		4			3,700
Do	Kruntzler's	1		1		1						
Right	Foot of Race street					2						
Left	D. Buchanan's	5		3		3	1		2			2,000
Right	Stevens's			1								
Do	Johnston's	4		3		1			3		1	1,000
Do	Levy's		2	4		2						
Left	Covington Saw-Mill			2								
Right	Marmet's			2		5			2		1	500
Do	Ohio River Salt Company's					1						
Do	Cochnower's, upper			4		2						
Left	Montgomery's			11		3			4			1,000
Right	Buchanan's			3		3						
Left	Covington Docks	1		16		1	1		4			1,000
Right	Gas Company's			8		2			8			7,000
Left	Bateman's	4		9			4		9			16,000
Do	Frenchman's					1					1	100
Right	Rolling-Mill			7		2			7		1	3,000
Do	Mueller's					6						
Do	Phillips's			6		3						
Do	Serena & Stone			4		3						
Do	Bard's	2	1	4		3		1				1,200
Do	Collier, Budd & Co.			3		2			3			500
Do	Cincinnati Coal and Coke Co	1	3	10		3	1	3	10		2	5,000
Do	Ross's			2		3						
Do	Fifth Street			2		3			2			1,000
Left	McCoy's			32					32			15,000
Right	Cochnower's, lower		1	7		4		1	7		2	5,100
Do	Zimmerman's			6		3			5			4,000
Do	Keck's					3					3	3,000
Do	Buckeye	1		2		1	1		1			1,150
Do	Mill Creek			5								
Do	Gaff's					1						
Left	Walmer's	3		38								
Do	Keystone					3						
Right	Flemming's	5		7	4	1	4		5	3		9,000
Do	Twenty-first Ward			6		2			6			1,200
Left	Walmer & Peckleheimer			22					10			2,000
Do	Crail & Wall	30		27	3	1	4		23	3	1	15,000
Right	Boldface			4		7					6	500
	Total	210	12	401	10	125	65	10	173	8	29	202,895

List of steamboats, wharf-boats, and model barges in port, showing their position and the loss from ice.

Name of boat.	Position.	Estimated loss.	Remarks.
Wildwood	Cincinnati dry-docks		
Exchange	Cincinnati marine ways		
Warner and two model barges	Foot of Bird street		
Laura L. Davis	Litherbury's		
Lily	do		United States light-house tender.
Hiram Watson	Gardner's		
Millie Roberts	N. and C. bridge, Newport		Small boat, slightly damaged.
Newport Belle and Float	Newport and Cincinnati Ferry Landings.		Ferry-boat.
Cincinnati Belle and Float			Do.
Calumet	Between Lawrence street and the suspension-bridge.	$30,000 00	
Vint Shinkle			
Golden City			
Telegraph			
Bostona			
Bonanza			
Big Sandy, wharf-boat		2,000 00	Damaged.
New Orleans, wharf-boat			
Andy Baum			
Andes		20,000 00	Sunk.
Mary Miller			
Emma Graham			
Shinkle's wharf-boat			
Champion No. 7	Mouth of Licking		
Champion No. 8	do		
Champion No. 9	do		
Ben Franklin	do		
Seven model barges	Up the Licking	50 00	One slightly damaged.
Louisville Mail-Line wharf-boat	Below suspension-bridge, Cincinnati.		
United States	do		
General Buell	Below suspension-bridge, Covington.		
Robert Peebles	Foot of Race street	350 00	A dismantled hull.
Central avenue ferry-boat and two floats.	Foot of Central avenue		Ferry-boat.
Hull of Nick Longworth	Sampson's Landing	50 00	Slightly damaged.
Kate Waters	On Covington docks		
Mark Twain	do		
Business	do		
Mocking Bird	Collier, Budd & Co.'s	2,000 00	Propeller, sunk.
Fanny Webster and three floats	Ludlow Ferry Landing	5,000 00	Boat and two floats destroyed.
Minnie Keenan	McCoy's Landing		Carried away and recovered.
Naomi	Ludlow	700 00	Destroyed.
Water Lily	do	500 00	Do.
Water Witch	Mill Creek	500 00	Do.
One model barge	Flemming's		
Liberty, and four model barges	Sedamsville	12,000 00	Loss of two model barges, loaded with salt and fire-brick.

SUMMARY.

Class.	In port.	Destroyed or damaged.	Estimated loss.
Freight and passenger steamboats	15	2	$50,000
Tow-boats	8	1	350
Ferry-boats	4	1	3,500
Small tugs and pleasure-boats	8	5	3,700
Model barges	14	3	12,550
Dismantled hull	1		
Wharf-boats and ferry-floats	12	4	3,550
United States light-house tender	1		
Total			73,650

HARBOR-ROOM REQUIRED.

As it is manifestly impossible to determine what will be the future amount of the commerce of Cincinnati, it will be assumed that harbor-room sufficient to provide for the craft that were actually in port on the 12th day of January, 1877, will answer the purpose of this report.

A coal-barge may be taken as measuring 130 by 24 feet, or 3,120 square feet. The net area of the harbor-room required for 623 coal-barges will therefore be 1,943,760 square feet, or 44.6 acres. If to this we add 10 per cent. as the least possible allowance for waste room and passage-ways, we shall have 49 acres as the harbor-room required to contain all the coal-barges that were in Cincinnati last winter.

The net area required to contain 135 flats, floats, and miscellaneous craft will be 270,000 square feet, or 6.2 acres; which increased by 10 per cent. becomes 6.8 acres. This added to the 49 acres previously found gives 55.8 acres as the area required to contain the water-craft included in our first table.

In getting the area required for steamboats we may omit all ferry-boats, wharf-boats, dismantled hulls, and diminutive steamboats of all kinds, thus reducing the number to be provided for to 24 steamboats (including tow-boats) and 14 model barges. Each steamboat may be assumed to require an area of 12,000 square feet, and each model barge an area of 4,500 square feet. For 24 steamboats there would therefore be required a net area of 288,000 square feet, or 6.6 acres; and for 14 model barges a net area of 6,300 square feet, or 1.5 acres; adding 10 per cent., as before, we find that the steamboats will require 7.3 acres, and the model barges 1.7 acres.

Collecting the areas found above, we have:

	Acres.
Area necessary for 623 coal-barges	49.0
Area necessary for 135 flats, floats, &c	6.8
Area necessary for 24 steamboats	7.3
Area necessary for 14 model barges	1.7
Total	64.8

It is thus shown that a water-surface of 64.8 acres, or in round numbers 65 acres, would be required to accommodate the winter commerce of Cincinnati.

AVAILABLE HARBORS.

The only harbors, properly so called, that can be made on a river like the Ohio are such as can be excavated out of its banks. The large tributaries are generally as dangerous as the main river, and the only resource is to dig into the shores, wherever there are low areas that will reduce the cost of excavation. The valleys of the creeks and small streams are naturally the only places where such areas can be found.

It is essential to the usefulness of a harbor that boats should always be able to get into it during the proper season.

The harbors herein discussed are solely designed for protection from ice-floods, as floods unaccompanied by ice are not dangerous.

The ordinary demands of commerce require that steamboats and barges be at their usual landings as long as possible. Steamboats can transact their regular business until the very day the river closes, as they have the ability to propel themselves to any desired point at a few hours' notice, and even to force themselves through thin ice. A con-

siderable amount of time would, however, be required to lay up barges for the winter.

It is thought that at least one month would be necessary for the transfer to the harbors of refuge of all the barges that are intended to be sheltered there, if the movement is to take place without confusion or vexatious delays.

The month in question would evidently be the month immediately preceding the closing of navigation. To ascertain at what date this may be expected the files of the Cincinnati Commercial have been carefully examined, and the following table, giving the dates and duration of the stoppage of navigation at Cincinnati during the last twenty years, has been compiled therefrom:

Winter.	Navigation suspended by running ice.	River entirely closed.	River open and navigation resumed.	Remarks.
1857-'58	....	....	....	No serious interruption.
1858-'59	....	....	....	No serious interruption; river high.
1859-'60	Jan. 2	....	Jan. 10	
1860-'61	....	....	....	No serious interruption.
1861-'62	....	....	....	Do.
1862-'63	....	....	....	No serious interruption; river high.
1863-'64	Jan. 4	Jan. 17	Jan. 25	
	Feb. 19	....	Feb. 23	
1864-'65	Jan. 30	....	Feb. 6	
1865-'66	Feb. 15	....	Feb. 20	
1866-'67	Dec. 30	....	Feb. 5	Occasional trips could be made.
1867-'68	Jan. 19	....	Jan. 23	
	Jan. 31	....	Feb. 15	Do.
1868-'69	....	....	....	No serious interruption.
1869-'70	....	....	....	No serious interruption; river high.
1870-'71	Dec. 24	....	Jan. 14	
1871-'72	Dec. 19	Dec. 21	Dec. 24	
	Dec. 28	Dec. 29	Dec. 31	
	Jan. 9	Jan. 10	Jan. 12	
	Jan. 27	Jan. 30	Feb. 20	
1872-'73	Dec. 13	Dec. 23	Jan. 4	Heavy ice running until February 6.
1873-'74	....	....	....	No serious interruption.
1874-'75	Jan. 12	Jan. 21	Jan. 30	
1875-'76	....	....	....	No serious interruption; river high.
1876-'77	Dec. 9	Dec. 19	Jan. 18	Ice began moving out January 13.

It will be seen from the above that during nine years out of the twenty examined, or during 45 per cent. of the winters, there was no stoppage of navigation by reason of ice. The earliest stoppage during the period in question was that of last winter (1876–'77), which began on the 9th of December. The next earliest was in the winter of 1872–'73, which began on the 13th of December. If, therefore, we make our harbors accessible on and after November 10, there will always be at least one month for barges to enter them.

Coal-barges usually draw 6½ feet, and ought to lie in at least 7 feet depth of water to prevent grounding. It is therefore evident that the conditions of the problem require that the proposed harbors of refuge shall have at least 7 feet of water from the 10th of November to the end of freezing weather.

An inspection of the gauge-records kept at this city since June, 1858, shows that the river is always higher in the latter part of the winter than in November and December.

The following table shows the dates, since 1858, at which the river has stood at less than 7 feet on the Cincinnati gauge between the 10th

of November and the 31st of December, together with the corresponding gauge-readings:

	′	″
1858.		
Nov. 23	6	9
24	6	6
25	6	4
26	6	2
27	6	0
28	6	10
29	7	7
1859.		
Nov. 10	4	9
11	4	9
12	5	0
13	10	0
14	7	4
15	6	0
16	8	2
1862.		
Nov. 10	5	1
11	5	1
12	4	0
13	4	9
14	4	7
15	4	6
16	4	5
17	4	4
18	4	3
19	4	3
20	4	1
21	5	2
22	4	4
23	4	0
24	3	11
25	3	11
26	3	11
27	7	0
28	12	6
Dec. 14	6	4
15	5	10
16	6	9
17	7	3
18	6	3
19	5	9
20	5	7
21	6	1
22	8	9
1863.		
Nov. 10	6	8
11	6	9
12	6	9
13	6	11
14	7	0
15	6	11
16	6	8
17	6	7
18	6	7
19	6	7
20	6	7

	′	″
1863.		
Nov. 21	6	10
1867.		
Nov. 14	6	11
15	6	10
16	6	8
17	6	4
18	6	1
19	5	8
20	5	5
21	5	2
22	4	11
23	4	10
24	4	8
25	4	7
26	4	5
27	4	3
28	4	3
29	4	2
30	4	3
Dec. 1	4	5
2	4	5
3	4	2
4	4	0
5	4	1
6	4	3
7	4	5
8	4	9
9	5	6
10	6	3
11	6	7
12	7	2
1869.		
Nov. 10	6	4
11	6	2
12	5	11
13	5	8
14	5	7
15	5	5
16	5	5
17	6	0
18	6	1
19	6	5
20	6	7
21	6	10
22	7	3
1871.		
Nov. 10	4	11
11	4	7
12	4	5
13	4	3
14	4	4
15	4	8
16	4	9
17	4	8
18	4	5
19	4	3

	′	″
1871.		
Nov. 20	4	5
21	9	9
Dec. 10	6	5
11	5	10
12	5	6
13	5	5
14	5	4
15	5	2
16	5	1
17	4	11
18	5	0
19	5	0
20	5	2
21	6	9
22	5	11
23	5	11
24	7	1
25	7	0
26	6	10
27	6	9
28	6	9
29	8	8
1877.		
Nov. 27	6	8
28	6	3
29	5	11
30	5	11
Dec. 1	5	11
2	6	5
3	6	7
4	6	7
5	6	4
6	6	0
7	6	0
8	6	9
9	8	4
1874.		
Nov. 10	3	0
11	3	0
12	2	11
13	2	10
14	2	11
15	3	0
16	2	11
17	3	0
18	3	1
19	3	3
20	3	7
21	3	5
22	3	4
23	4	8
24	4	10
25	4	11
26	4	10
27	8	7

The above table shows that the lowest water during the period under examination was in November, 1874, and that the lowest reading was 2 feet 10 inches on the gauge. The next lowest water during the same period occurred in November, 1862, and read 3 feet 11 inches on the gauge. There was no serious interruption from ice during the winter of 1862–'63, and in the winter of 1874–'75 the river did not close until January 12; but these conditions could not have been foreseen, and we may therefore still assume that had ice-harbors been available, coal-barges would have been in them at the times of these lowest stages. To have kept these barges from grounding in the worst of the two seasons, the bottom of the harbors should be 7 feet below the lowest gauge-reading given above—or, in other words, they should be 4 feet 2 inches below the zero of the gauge. It will suffice, however, to put them at an even 4 feet below this

level, and this depth has, therefore, been taken for the excavation of the proposed harbors of refuge.

In order to avoid as much as possible the construction of masonry, it is assumed in the estimates that the sides of the basins will be payed slopes instead of retaining-walls. For the same reason the entrances have been considered as having paved slopes, although masonry walls would undoubtedly be much better for this purpose.

Several localities for harbors, otherwise desirable, are unavailable because they are on the convex bank of the river—in other words, because they are on the side where the tendency of the currents is to cause deposits and make sand-bars. Occasional dredging will probably be necessary in order to keep open the mouth of any recessed harbor, even though made on a favorable shore, unless a scour can be established through it by means of a large and continuous supply of water entering the basin from the land behind. It would be hopeless to attempt to keep open the mouth of a harbor which is both on the convex bank and is without an independent supply of water. A harbor that would probably give continuous occupation to one or more dredges had better not be attempted.

MOUTH OF THE LITTLE MIAMI.

A harbor with an area of 31 acres has been surveyed on the right bank of the Ohio and the right bank of the Little Miami, at the mouth of the latter. Such a harbor is indicated on sheet A, the general map of the harbor of Cincinnati, and is also shown in detail on sheet No. 2. A much larger area than 31 acres can be obtained here, if desired, but the survey only included this amount, and as there are some strong objections to a harbor at this locality, it has been thought best to prepare the estimate on the area actually surveyed. The whole estimated space of 65 acres can be obtained here without difficulty.

The design is to excavate in the lower angle between the Miami and the Ohio, using the excavated material to protect the excavation from floods in either river. In order to obtain the necessary water-supply, with sufficient current to keep open the outlet of this harbor, it would probably be necessary to build a dam across the Miami and provide it with sluices leading into the basin. The outlet would lead directly into the Ohio, as is shown in map No. 2.

In this part of the Ohio the strongest current is along the left shore, the current along the right shore being comparatively slack. The Little Miami has across its mouth a bar of sand and gravel that is almost dry in low water. It may therefore be considered as certain that an entrance into the harbor through the mouth of this river would require a large amount of dredging each year to keep it open at all stages of water.

The amount of excavation to make a basin of the area of thirty-one acres would be 2,318,800 cubic yards, which, at 30 cents per cubic yard, would amount to $695,640.

The average depth of the excavation would be 41.1 feet. The surface to be paved would be 53,745 square yards, which, at $1 per square yard, would amount to $53,745.

The cost of building a dam across the Little Miami, and constructing proper sluices into the basin, would amount to about $60,000.

It must be borne in mind that in order to procure 31 acres of harbor-room at low water, it will be necessary to purchase enough additional land to provide for the sloping sides of the basin. In the case in hand this additional land amounts to 15 acres, thus compelling the purchase

of 46 acres to secure a low-water harbor of 31 acres. At an assumed price of $100 per acre this land will cost $4,600.

The total cost of a harbor of refuge at this point, having an area of 31 acres, would therefore be $813,983, which is at the rate of $26,258 per acre of harbor-room.

CRAWFISH CREEK.

The next point examined is at the mouth of Crawfish Creek, between the railroad and the river. The area surveyed is shown on the general map, and the details of the ground on sheet No. 1.

This harbor is favorably situated for access at all stages, as its outlet is through a concave bank, passing directly into the deep water that is always found near such banks. There is no tendency to deposit along the shore near the mouth of Crawfish Creek, and the only dredging that would probably be required at this harbor would be the removal of the small deposits that would work into the entrance from the slight eddy that would naturally form there.

In calculating the amount of excavation at this locality, and the available area for shipping, it was thought best not to pass beyond the bounds of the natural depression, as any digging into land whose surface is on a level with the river-bank would be exceedingly expensive without adequate result. With due allowance for side slopes, this natural basin gives an available harbor-area of 13 acres. The nature of the material to be excavated was determined by boring through it to a depth of 4 feet below low water. As shown on the map, the hole was sunk in the bed of the creek nearest to the base of the hills, where it was thought most likely that rock would be found. No rock was found, however, and the material for the whole depth proved to be fine gravel and sand. The same kind of material probably prevails throughout the whole area of the basin.

The amount of excavation required for the harbor proposed would be 922,000 cubic yards, which, at 30 cents per cubic yard, would cost $276,600. The average depth of excavation would be 40.9 feet. The amount of paving would be 32,700 square yards, which, at $1 per square yard, would cost $32,700. The land required would cost, as far as I can learn, about $700 per acre; 19 acres will be required, and the cost of the tract would therefore be $13,300.

The total cost of a harbor at this locality would therefore be $322,600, or an average of $24,815 per acre of harbor-room.

Should this part of the city become thickly populated it might then be necessary to cross the outlet of the harbor by a draw-bridge, but as this is not a present necessity no allowance has been made for it in the estimates.

MILL OR TAYLOR'S BOTTOM.

The next point to be considered as we descend the river is Mill or Taylor's Bottom, which lies along Taylor's Creek, between the towns of Newport and Bellevue in Kentucky.

A report on the proposition to make a harbor at this locality was made by me on the 5th of February, in response to a resolution of the House of Representatives, dated January 30, 1877. This report is printed as Ex. Doc. No. 39, Senate, Forty-fourth Congress, second session.

The chief obstacle to utilizing Taylor's Creek Bottom for a harbor of refuge is the sand-bar that lies across its mouth, and which in low water is dry to within one square of the Newport and Cincinnati bridge. This

is the natural sand-bar of a convex shore, and there is no way of keeping open a channel through such a bar, except by constant dredging or the continual scour of a large volume of water issuing from the mouth of the creek. As the latter is usually very nearly dry in summer and fall, it was manifest that the natural conditions at this locality were an insuperable barrier to the creation of a practicable harbor, and therefore no detailed survey was made.

MOUTH OF THE LICKING.

The Licking River itself is much used as a harbor of refuge, but it is considered a hazardous one, as this stream is subject to rapid rises that make it unsafe even in summer. In obedience to the act of Congress, approved March 3, 1871, I made a survey of the mouth of the Licking as a harbor of refuge, and my report was printed in Ex. Doc. No. 252, House of Representatives, Forty-second Congress, second session. It was also reprinted in the Annual Report of the Chief of Engineers, for 1872, pp. 420–425, and I would refer to these documents for further information, merely stating that the largest lateral harbor that could well be made near the mouth of the Licking was estimated to give an available area of 9.8 acres, and that its least cost was estimated at $741,000, of which $167,000 was the cost of excavating a channel through the wide rock-bar that now obstructs the mouth of this river.

WILLOW RUN.

The next point that requires investigation is the basin of Willow Run, a small stream on the Kentucky side that enters the Ohio at the lower or western edge of the city of Covington. This location has the advantage of deep water at the mouth of the creek, and of being nearly opposite the centre of Cincinnati. The detailed survey of this tract is shown on sheet No. 3.

The area of the basin laid out in this bottom is 19.3 acres. The width of the entrance is taken at 100 feet, except at the crossing of Third street. Here a draw-bridge would evidently be required, and in order to avoid having so great a weight as to require the use of steam for turning it, the width of clear opening has been placed at 60 feet.

The average depth of excavation is 46.4 feet, and the total amount to be excavated is 1,553,000 cubic yards. This, at 30 cents per cubic yard, would cost $465,900. The total surface to be paved is 50,700 square yards, which, at $1 per square yard, amounts to $50,700. The cost of the draw-bridge at Third street, with its abutments and pivot-piers, would be about $45,000. The cost of the ground is an uncertain item, as none of it is utilized at present, and its future value depends entirely upon the growth of the city of Covington. But some price would have to be paid for land if a harbor of refuge were made in this locality, and therefore I have placed it at $2,000 per acre, which is about the average price put upon it by real-estate dealers in Covington. As 27 acres would be required in order to secure 19.3 acres of harbor-room at low water, the total cost of the land would be $54,000.

Adding these items we find that the cost of this harbor would be $615,600 for 19.3 acres, or at the rate of $31,900 per acre of harbor-room.

The estimate is based on the supposition that no rock will be found in excavating to the required depth. Two test borings (positions indicated on the map) were made to a depth of 4 feet below low-water level without encountering any other material than alluvial deposits of gravel, sand, and clay.

MILL CREEK.

The next available point is the valley of Mill Creek, an Ohio stream that enters the river in the lower part of Cincinnati. Both banks of this stream, within 5 miles of its mouth, are within the corporate limits of Cincinnati.

A resolution of the House of Representatives, dated January 17, 1877, called for a special report on the expediency and utility of constructing a harbor of refuge at this point. By direction of the Chief of Engineers, I made such a report, and it was printed as Ex. Doc. No. 34, House of Representatives, Forty-fourth Congress, second session. I would respectfully refer to that document for my reasons for considering a harbor of refuge in Mill Creek bottom as impracticable. As a careful examination of this project, made subsequent to the report in question, failed to develop any new points in its favor, no special surveys have been made in this bottom. The location is indicated on the general map.

PLEASANT RUN, BROMLEY.

This was the lowest locality examined. Pleasant Run is a small stream that enters the Ohio from the Kentucky shore at a point one and a half miles below the Cincinnati Southern Railway bridge. The point on the Kentucky shore, immediately opposite the lower boundary-line of Cincinnati, is 1,500 feet below the mouth of Pleasant Run.

The available low-water area for a harbor in the valley of this stream is 30.3 acres. The low area is some distance back from the river, and is reached by an entrance 60 feet in width. The average depth of excavation is 40.8 feet, and the total amount is 2,031,000 cubic yards, which, at an average price of 30 cents per cubic yard, would cost $609,300. The surface to be paved is 45,000 square yards, which, at $1 per square yard, will cost $45,000. As the mouth of the run is now crossed by a fixed bridge, this would have to be replaced by a draw-bridge. With the usual openings of 60 feet, such a bridge would cost, including masonry and piers, about $45,000.

Two test borings were made to determine the nature of the excavation required. Their position and the particular nature of the materials found are shown on the special map of the site, which is marked sheet No. 4. Both holes were sunk to 4 feet below ordinary low water, and they show that, to the depth required, this basin, like the others, contains mainly an alluvial deposit of sand, clay, and fine gravel. The soft clay-stone exposed in the bed of the creek on the south side of the basin limits the harbor on that side. It is believed that due allowance has been made for this rock, although the funds allotted for the work would not permit sufficient borings to determine its exact position.

This harbor, like that at the mouth of the Little Miami, opens on a shore where the current is not strong, and where deposits are likely to appear if the present regimen is changed, either by excavating an outlet or by building dikes. It is therefore probable that the entrance to this harbor would have to be kept open by constant dredging.

The value of the land is, as usual, indeterminate; but the best information puts its present price at $50 per acre, and as 41 acres would be required, its cost would be $2,050.

The total cost of this harbor would, therefore, be $701,350, which is at the rate of $23,147 per acre of harbor-room.

SUMMARY.

Summing up in tabular form the results that have been determined above, we have—

	Little Miami.	Craw-fish.	Willow Run.	Pleasant Run.
Average depth of excavation .... feet..	41.1	40.9	46.4	40.8
Amount to be excavated .... cubic yards..	2,318,800	922,000	1,553,000	2,031,000
Cost of excavation	$695,640	$276,600	$465,900	$609,300
Surface to be paved .... square yards..	53,745	32,700	50,700	45,000
Cost of paving	$53,745	$32,700	$50,700	$45,000
Cost of dam and sluices	60,000	....	....	....
Cost of bridges	....	....	45,000	45,000
Cost of land	4,600	13,300	54,000	2,050
Total cost of harbor	813,985	322,600	615,600	701,350
Available area .... acres..	31	13	19.3	30.3
Cost per acre of harbor	$26,258	$94,820	$31,900	$23,147

It is proper to repeat that there is no difficulty in obtaining as much harbor-room as may be needed at the mouth of the Little Miami, although the survey only embraced 31 acres, and that an increase in the area of harbor would reduce the cost per acre by apportioning the cost of the entrance and of the sluices among a greater number of acres.

On account of the difficulty of keeping open their entrances, it is thought that neither the mouth of the Little Miami nor Pleasant Run is available as a site for a harbor of refuge. Of the four sites to which our choice is practically limited, the two just named have the additional disadvantage of having the most inconvenient locations, the former being above the upper boundary of the city, and 7 miles above the suspension-bridge (which is practically the middle point of the harbor of Cincinnati), and the latter about opposite the lower end of the city. The distance between the outlets of these two projected harbors is therefore 10¼ miles, the length of river between the corporate limits of Cincinnati being 9 miles.

The only sites in this vicinity that are at all practicable are Crawfish Creek and Willow Run, both of which combined would only give a harbor-room of 32.3 acres, instead of the 65 acres which our preliminary calculation showed to be necessary for the complete protection of the shipping of Cincinnati. We may, therefore, sum up by stating that our investigations have developed the fact that one-half the shipping of Cincinnati could be sheltered in harbors of refuge at a cost of $940,000. The locations of these two harbors are very good. Crawfish ice-harbor, 4½ miles above the suspension-bridge, would be of convenient access to the boats that frequent the upper part of the harbor of Cincinnati, and Willow Run, three-quarters of a mile below the suspension-bridge, would accommodate the central and lower parts of the harbor.

After consultation with persons interested in the river-commerce of Cincinnati, I have come to the conclusion that it is unnecessary to provide for more than one-half of this commerce, as the majority of the steamboats will remain at their landings until the river closes, trusting that the detention will be slight, or that, if it should be long, they will escape injury, as the greater number always do escape. As far as the steamboat-interest is concerned, harbors of refuge are only needed for steamboats that are not in commission when the river closes, and for the few others that may be able to reach these harbors after the river has frozen up. An allowance of one-half the calculated area will therefore probably suffice for the steamboat-interest.

The chief reason why the coal-interests desire a harbor of refuge is that they may obtain secure shelter for their reserve supply, the greater part of which is now stored above and below the harbor proper. But even with harbors of refuge, the majority of coal-owners would always keep a large number of barges at their landings all winter in order to meet the ordinary demands of consumers. For this reason, I think that one-half of the estimated harbor-room would suffice for the coal-interest. It follows from the above that the projected harbors at Crawfish Creek and Willow Run would probably suffice to contain all the boats that would use them if constructed.

OTHER METHODS OF PROTECTION.

This report would not be complete were it to omit to mention other methods of protection for boats that cannot or will not leave their landings and enter an artificial ice-harbor.

Ice-breakers.—In the pools of the Monongahela, where many coal-boats and barges are harbored, protection from ice is secured by ice-breakers. These are usually spur-dikes, projecting at right angles from the bank and extending into the river far enough to cover as wide a front of barges as it is intended to shelter. These spur-dikes are not continuous structures, but consist of a line of disconnected cribs filled with stone, and having intervening spaces usually as wide as the cribs themselves. The object of these openings is to give passage to the current so as to prevent shoals from forming under the lee of the cribs. The down-stream faces of the cribs are vertical, and the up-stream faces have a very gentle slope, so as to reduce as much as possible the shock of ice and drift.

Such structures at the upper end of every coal-landing would greatly reduce the danger from ice. The best possible ice-breaker would be one that could be put in place in the autumn and be removed in the spring. It would thus give protection when protection is needed, and would be out of the way at times when its tendency to form a shoal below it would be a decided objection. Such an ice-breaker is, however, yet to be devised.

Sheer-booms.—The United States river-monitors that lay so long at Mound City were protected from ice and drift by a sheer-boom of heavy iron-plated timbers that was attached to the shore at a point above the fleet, and extended down far enough to cover the boats to be protected by it. This system is free from the objection of causing deposits below it, and it seems worthy of serious consideration as a method of protecting steamboats and model barges. The shock of a field of ice against such a boom would be at once transmitted to the boats behind it, but it would be distributed over so great an area as to act rather as a push than as a blow. The injury to steamboats is usually caused by the impact of the corner of an ice-field against a small part of the hull that yields to the shock, and, by admitting water, causes the boat to sink. The same blow distributed over a wide surface of the same hull would be successfully resisted.

For coal boats and barges the ice-breakers are apparently better than sheer-booms, as they afford much more reliable means of fastening the fleet.

Harbor-boat.—A harbor-boat that could be relied upon to break up the harbor-ice whenever such a course was deemed advisable, would, at times, be very useful. Whether its occasional use would justify its constant expense is a question that is open to argument. The strongest

point against such a boat is the fact that the city of Saint Louis built one, and after a trial of a few seasons ordered it to be sold. In any event, the construction of ice-breakers and sheer-booms to protect either public or private landings in Cincinnati does not seem to be a proper work for the general government to undertake, and the purchase and management of a harbor-boat apparently falls into the same category.

Dike at Four-Mile Bar.—It has been strongly asserted by several Cincinnati coal-dealers that the government dike at Medoc, eighteen and a half miles below the suspension-bridge, has done them considerable indirect injury, by causing ice-gorges to begin at that point, and then gradually back up into the harbor of Cincinnati, which thus becomes closed. They have suggested that if a similar, but slightly higher, dike were built at Four-Mile Bar, ten miles above the suspension-bridge, it would cause the river to gorge at that point before it did at Medoc, and that the effect would be to hold back the running ice so that the Medoc gorge would not receive sufficient re-enforcements to enable it to extend back to Cincinnati.

The theory is plausible, and ought to be tested, for the reason that Four-Mile Bar is greatly in need of improvement by dikes, being one of the worst bars on the river, and one that has often been selected for improvement, but laid aside for lack of funds. Dikes at this point are a necessity of commerce, whether they hold back ice or not.

CONCLUSION.

In closing this report, it seems proper to add that the chief cause of the great expense of any ice-harbor at Cincinnati is due to the great oscillation in the river-surface. Three of the low areas which have been examined average twenty-seven feet below the level of extreme high water, which fact, considered by itself, would seem to indicate that but a small depth of excavation would transform any one of them into a harbor of refuge; but when we learn that extreme high water at Cincinnati reads sixty-four feet on the gauge, and when we recall the fact that our preliminary investigation showed that we must excavate our harbors to a depth of four feet below the zero of this gauge, or to a depth of sixty-eight feet below high-water mark, we readily perceive how a level of twenty-seven feet below high water is compatible with an average excavation of forty-one feet.

For the maps which accompany this report I am indebted to Mr. William Weston, assistant engineer, and to his assistant, Mr. L. Petitdidier. To the former I am also indebted for the preparation of the very complete statistics, the collection of which, from innumerable sources, required an unusual amount of patience, industry, and perseverance.

Respectfully submitted.

WILLIAM E. MERRILL,
Major of Engineers.

Brig. Gen. A. A. HUMPHREYS,
Chief of Engineers United States Army.

CONTINGENT FUND OF INTERIOR DEPARTMENT.

LETTER

FROM

THE SECRETARY OF THE INTERIOR,

TRANSMITTING

Detailed account of the expenditure of the contingent fund of that department.

FEBRUARY 5, 1878.—Referred to the Committee on Expenditures in the Interior Department and ordered to be printed.

DEPARTMENT OF THE INTERIOR,
Washington, D. C., January 30, 1878.

SIR: I have the honor to transmit herewith, as required by section 193 of the Revised Statutes, statements of the expenditures of the contingent funds of the several bureaus of this department for the fiscal year ending June 30, 1877.

I am, sir, very respectfully,

C. SCHURZ,
Secretary.

Hon. SAMUEL J. RANDALL,
Speaker of the United States House of Representatives.

DEPARTMENT OF THE INTERIOR.

Statement of expenditures on account of the contingent fund of the Secretary's Office, Department of the Interior, for the fiscal year ending June 30, 1877.

Date.	From whom purchased.	Nature of purchases, &c.	Amount.
1876.			
July [illegible]	G. M. Wight	Furniture	$24 00
Aug. 2	Gheen & Osborn	Livery	25 00
2	George Ryneal, jr.	Purifying powder	38 00
3	E. J. Hayward	Washing towels	5 31
4	Atlantic and Pacific Telegraph Co.	Telegram	25
5	Evening Star	Advertising	75 00
7	Adams Express Company	Expressage	80
12	......do	......do	40
17	H. J. Hart	Insect powder and bellows	5 50
[illegible]	W. H. & O. H. Morrison	Book-case	20 00
[illegible]	C. H. Emerson & Co.	Subscriptiont o Business Guide of Washington, D. C.	5 00
[illegible]	Metropolitan Railroad Company	Car tickets	10 00

Statement of expenditures on account of the contingent fund, &c.—Continued.

Date.	From whom purchased.	Nature of purchases, &c.	Amount.
1876.			
Aug. 20	Adams Express Company	Expressage	$0 40
28	Western Union Telegraph Co	Telegrams	8 65
29	E. M. Whitaker	Ruling pens and envelopes	20 50
30	William Ballantyne	Stationery	17 50
31	Benjamin Moten	Paste	2 00
Sept. 1	Thomas Norfleet	Harness and repairs	10 25
4	Adams Express Company	Expressage	1 35
5	E. J. Hayward	Washing towels	6 48
5	Gheen & Osborn	Livery	25 00
6	Robert Beall	Stationery	121 34
6	E. Q. Gunson & Co	Books	2 40
7	Atlantic and Pacific Telegraph Co	Telegrams	4 50
9	Joseph L. Savage	Shears	126 50
14	L. H. Schneider	Scales, screws, and locks	43 15
14	George Wooldridge	Soap	151 25
18	Z. D. Gilman	Gum arabic and feather-dusters	132 45
25	James St. John Stationery Co	Stationery	259 20
27	Western Union Telegraph Co	Telegrams	5 82
27	William H. Dempsey	Stationery	13 87
28	John C. Hogan	Recovering awning	6 00
30	Washington Fast Freight Line	Freight	75
30	Willet & Libbey	Lumber	80 80
30	Adams Express Company	Expressage	40
30	Great Falls Ice Company	Ice	65 52
30	Gheen & Osborn	Livery	25 00
30	B. W. Reed's Sons	Brooms, soap, sponge, and baskets	93 50
Oct. 5	E. J. Hayward	Washing towels	4 74
12	L. H. Schneider	Hardware	9 97
13	Atlantic and Pacific Telegraph Co.	Telegrams	5 48
14	J. G. Weaver	Putting down carpets	25 00
14	G. W. Joy	Horseshoes	11 35
16	Adams Express Company	Expressage	1 10
16	George W. Knox	Freight	75
20	Solomons & Chapman	Stationery	2 50
20	Joseph L. Savage	Hardware	13 55
23	G. M. Wight	Furniture	48 00
24	Adams Express Company	Expressage	45
25	George Herbert	Books	11 80
25	Western Union Telegraph Co	Telegrams	41 43
26	Joseph Dixon Crucible Company	Stationery	36 00
26	American Library Journal Co	Subscription	5 00
27	George C. Maynard	Repairing battery	5 50
28	Metropolitan Railroad Company	Car tickets	10 00
30	Henry Compton	Cartage	50
31	Benjamin Moten	Paste	2 50
Nov. 1	Adams Express Company	Expressage	80
1	B. W. Reed's Sons	Sundries	25 20
3	W. D. Wyvill	New grate and repairs	34 00
4	Gheen & Osborn	Livery	25 00
10	Henry Badger	Cartage	1 00
13	Willet & Libbey	Lumber	18 88
14	W. D. Allen	Books	4 50
15	E. J. Hayward	Washing towels	4 35
16	Atlantic and Pacific Telegraph Co	Telegrams	36
16	Solomons & Chapman	Stationery	979 99
17	George D. Wood	Cartage	50
20	Herman Baumgarten	Stamp	8 00
23	Washington and Georgetown Railroad Company.	Car tickets	10 00
23	Western Union Telegraph Co	Telegrams	5 67
24	Henry Badger	Cartage	50
25	Walter Allen	Books	3 00
27	Perry & Bro	Cotton	4 05
28	The Nation	Subscription	5 20
29	A. D. F. Randolph	Books	34 20
Dec. 1	D. Appleton & Co	......do	5 60
2	Gheen & Osborn	Horse	400 00
2	......do	Livery	39 50
2	William Smith	Repairs	3 00
4	George Herbert	Books	4 75
6	W. S. Mitchell	Carpets	179 40
7	Henry Badger	Cartage	50
8	E. J. Hayward	Washing towels	4 74
8	George W. Knox	Freight	5 44
11	William Ballantyne	Stationery	68 05
12	Franklin Telegraph Company	Telegrams	13 00
13	G. N. Rider	Books	4 50
13	John McDermott & Bro	Repairs	4 60
14	George C. Maynard	......do	11 75
16	The Pyramid Pin Company	Pins	86 20

Statement of expenditures on account of the contingent fund, &c.—Continued.

Date.	From whom purchased.	Nature of purchases, &c.	Amount.
1876.			
Dec. 18	E. Q. Gunson & Co	Books	$3 60
19	George W. Knox	Freight	1 52
26	M. Jacobs	Stationery	108 00
30	Western Union Telegraph Co	Telegrams	1 98
30	W. H. Nalley	Repairs	2 00
30	Hamilton & Pearson	Grate-fender	11 00
30	Robert Beall	Books	4 00
30	Gheen & Osborn	Harness, livery, and horseshoes	106 50
30	Thomas Norfleet	Harness	26 00
30	Great Falls Ice Company	Ice	52 08
30	William Ballantyne	Books	2 80
30	A. D. F. Randolph	.....do	36 48
30	E. H. King	Repairs	11 00
30	Metropolitan Railroad Company	Car tickets	10 00
30	B. W. Reed's Sons	Sundries	37 93
30	P. Wilson and others	Cleaning snow	51 80
15	Daniel Kolb	Sundries	7 90
15	E. M. Whittaker & Son	Stationery	209 80
16	George C. Maynard	Electric bell	46 00
1877.			
Jan. 8	Evening Star	Subscription	2 64
8	E. J. Hayward	Washing towels	4 35
8	Adams Express Company	Expressage	2 30
10	L. H. Schneider	Hardware	25 11
10	John Markriter	Shade	3 00
10	D. S. Hoffard, agent	Book	4 25
11	A. D. F. Randolph	Books	16 00
11	E. Morrison	Stationery	10 52
12	Shmedtie Brothers	Repairs	2 00
13	George W. Knox	Freight	50
15	B. C. Jones	Repairs	10 00
15	George Wooldridge	Soap	22 50
17	Adams Express Company	Expressage	30
23	Atlantic and Pacific Telegraph Co	Telegrams	3 39
26	W. H. Dempsey	Stationery	45 00
27	G. N. Whittington	Books	45 00
27	J. Bradley Adams	City Directories	35 00
29	Adams Express Company	Expressage	80
Feb. 1	Francis Miller	Brushes	11 00
1	J. W. Gregory	Pails	6 00
2	Gheen & Osborn	Livery and repairs	31 75
3	National Republican	Subscription	8 00
3	.....do	.....do	8 00
3	E. J. Hayward	Washing towels	5 52
3	John C. Parker	Subscription to New York Herald and Tribune.	24 00
6	George W. Knox	Freight	1 00
6	George Herbert	Books	2 00
8	R. McMurray	Leather straps	66 00
10	J. Bradley Adams	Stationery	39 55
13	Adams Express Company	Expressage	55
13	Metropolitan Railroad Company	Car tickets	10 00
13	J. Bradley Adams	Stationery	145 83
16	McMenaway & Co	Book	1 20
20	W. H. Dempsey	Stationery	34 56
20	G. N. Rider	Books	4 00
21	W. W. Farr	Repairs	5 00
24	George W. Knox	Freight	1 00
24	R. Jones	Book	4 25
27	C. H. Nourse & Co	Gum camphor	15 00
Mar. 1	B. W. Reed's Sons	Sundries	12 80
1	Gheen & Osborn	Livery and repairs	29 00
1	Robert Beall	Books	4 50
7	George W. Knox	Freight	50
7	E. J. Hayward	Washing towels	4 65
7	George Wooldridge	Soap	36 00
8	Robert Beall	Atlas	20 00
9	Thomas Bowie	Cartage	50
9	J. D. McBride	Map	32 00
10	Willet & Libbey	Lumber	8 05
10	John Markriter	Gold-wire cord and screw-eyes	11 72
10	W. H. Dempsey	Stationery	60 00
12	Adams Express Company	Expressage	90
12	L. H. Schneider	Hardware	7 98
14	William Ballantyne	Books	47 00
15	E. Morrison	Stationery	13 68
15	Joseph L. Savage	Hardware	88 75
15	Adams Express Company	Expressage	90
17	S. J. Meeks	Repairs	3 00
19	Stanley Rule and Level Company	Rulers	15 20

Statement of expenditures on account of the contingent fund, &c.—Continued.

Date.		From whom purchased.	Nature of purchases, &c.	Amount.
1877.				
Mar.	19	Germond Crandell	Books	$19 80
	21	McFarland & Stephenson	Cartage	1 05
	22	Wiswall & Gynn	Towels	28 50
	22	A. D. F. Randolph	Books	72 76
	22	A. Hoen & Co.	Lithographing	85 25
	23	Atlantic and Pacific Telegraph Co	Telegraphing	6 03
	23	......do	......do	38
	23	J. W. Boteler & Bro.	Sundries	5 38
	31	George C. Maynard	Repairs	4 00
	31	Gheen & Osborn	Livery and repairs	46 50
	31	W. H. Dempsey	Stationery	129 46
	31	......do	......do	130 00
	31	Great Falls Ice Company	Ice	44 96
	24	Western Union Telegraph Co.	Telegrams	3 71
	24	Dobler, Midge & Chapman	Stationery	190 00
	26	George Wooldridge	Soap and sponge	17 75
	27	Metropolitan Railroad Company	Car tickets	10 00
	27	W. B. Moses	Furniture	40 00
	28	A. Arend	Rubber stamp, ink, and pad	1 75
	30	George Wooldridge	Soap and sponge	25 13
	31	B. W. Reed's Sons	Baskets	15 50
Apr.	7	W. H. Nalley	Repairs	30 00
	7	John McDermott & Bro	......do	150 00
	7	J. B. Adams	Books	4 90
	9	George W. Knox	Freight	50
	10	E. Q. Gunson & Co	Books	3 60
	12	Atlantic and Pacific Telegraph Co.	Telegrams	2 18
	13	Norris Peters	Photolithographing	55 00
	17	William Ballantyne	Books	7 04
	19	Virginia Sentinel	Advertising	1 20
	19	W. O. Lycett	Making boxes	9 00
	20	Washington and Georgetown Railroad Company.	Car tickets	10 00
	21	W. H. Nalley	Repairs	15 00
	21	J. M. Schriver	Book	5 00
	23	Thomas Bowie	Cartage	1 00
	23	Ida Brumdgim	Book	2 75
	26	E. H. King	Walnut case	120 00
	26	J. F. Gedney	Engraving and stamping	24 50
	27	Mohun Bros	Stationery	221 38
	27	Metropolitan Railroad Company	Car tickets	10 00
	30	A. H. Stockman	Book	1 00
May	2	Gheen & Osborn	Livery	33 00
	2	E. J. Hayward	Washing towels	10 51
	3	William Ballantyne	Stationery	33 03
	3	......do	Books	56 73
	4	Charles Fischer	Repairs	20
	5	Gheen & Osborn	Horse	175 00
	5	J. Disturnell	Books	12 00
	7	J. C. Laing	......do	2 90
	9	Solomons & Chapman	......do	14 00
	10	George Wooldridge	Soap and sponge	45 25
	12	Armour & Montrop	Painting	8 00
	14	Adams Express Company	Expressage	25
	15	Lockwood, Brooks & Co	Books	17 85
	16	Western Union Telegraph Co.	Telegrams	29 94
	17	......do	......do	5 00
	17	W. W. Nottingham	Sawdust	8 85
	19	James H. Stone	Ink	5 01
	21	Leonard Scott Publishing Co.	Subscription to British Quarterly Review	12 00
	21	Wash. B. Williams	Furniture	150 86
	22	J. Gotthelf	Fans	1 20
	22	George Wooldridge	Combs and brushes	9 90
	22	Atlantic and Pacific Telegraph Co	Telegrams	53
	24	S. Oppenheimer	Microscope	1 50
	24	Reissner & Jenks	Water-cooler	5 00
	25	J. F. Gedney	Stamping paper and envelopes	17 50
	28	Mrs. J. C. Patton	Books	2 00
	31	M. E. Mann	Book	6 00
June	1	Gheen & Osborn	Livery and repairs	55 00
	1	George C. Maynard	Repairs	7 25
	2	J. G. Weaver	......do	4 50
	4	E. J. Hayward	Washing towels	6 58
	4	B. W. Reed's Sons	Tumblers	61 62
	6	L. H. Schneider	Hardware	8 19
	6	John Markriter	Miscellaneous	36 66
	7	Metropolitan Railroad Company	Car tickets	10 00
	7	Thomas Norfleet	Harness	20 25
	7	M. G. Copeland	Awnings	62 00
	8	William Ballantyne	Books	36 20
	8	......do	Stationery	56 78

Statement of expenditures on account of the contingent fund, &c.—Continued.

Date.	From whom purchased.	Nature of purchases, &c.	Amount.
1877.			
June 9	E. H. King	Desk and repairs	$167 50
11	George Wooldridge	Soap	15 00
11	W. B. Moses	Furniture	46 50
12	H. F. Beecher	Stationery	15 56
12	Western Union Telegraph Co	Telegrams	7 37
12	Franklin Telegraph Company	......do	57
14	Solomons & Chapman	Stationery	60 91
15	Joseph L. Savage	Hardware	21 00
15	E. W. Woodruff	File-holders	330 00
16	George Hill	Stationery	2 10
16	Mohun Brothers	......do	94 37
22	Germond Crandell	Books	5 80
23	E. M. Whittaker	Stationery	49 20
25	J. Bradley Adams	......do	62 03
26	Adams Express Company	Expressage	25
27	George C. Maynard	Repairs	10 50
27	William Ballantyne	Stationery	39 42
27	George Wooldridge	Soap	24 00
27	John C. Hogan	Repairs	9 50
29	W. H. & O. H. Morrison	Books	73 00
29	W. S. Mitchell	Carpets and matting	417 67
30	W. B. Moses	Furniture	50 55
30	Robert Beall	Books	2 00
30	George Herbert	......do	2 60
30	G. W. Joy	Horseshoes	4 00
30	J. L. Onderdonk	Map	1 00
30	G. M. Wight	Furniture	20 00
30	William Ballantyne	Books	11 40
30	Gheen & Osborn	Livery and repairs	54 00
30	John McDermott & Bro	Wagon	160 00
30	......do	Repairs	6 00
30	A. H. Stockman	Books	1 00
30	Gebbie & Barrie	......do	14 00
30	Great Falls Ice Company	Ice	52 64
30	E. J. Hayward	Washing towels	5 94
30	Evening Star	Subscription	2 64
30	W. W. Farr	Repairs	2 00
30	G. W. Joy	Horseshoes	4 50
30	J. W. Boteler & Bro	Miscellaneous	26 30
30	Atlantic and Pacific Telegraph Co	Telegrams	25
30	W. H. Boyd	Directories	14 00
30	Western Union Telegraph Co	Telegrams	11 14
July 9	John Markriter	Screen*	2 00
13	W. B. Williams	Furniture*	14 00
24	Solomons & Chapman	Stationery*	19 35
Aug. 16	A. D. F. Randolph & Co	Books*	2 00
Sept. 22	E. W. Woodruff	File-holders*	73 33
30	Thomas Norfleet	Repairs*	2 00
	Amount expended		9,963 77
	Balance on hand unexpended		36 23
	Amount appropriated		10,000 00

* These accounts were contracted during fiscal year ending June 30, 1877.

Statement of expenditures on account of the contingent fund of the General Land Office for the fiscal year ending June 30, 1877.

Date.	From whom purchased.	Nature of purchases, &c.	Amount.
1876.			
July 15	J. G. Weaver	Repairing furniture	$319 56
21	J. Bradley Adams	Stationery	109 00
21	James Hudson	Painting rooms	200 00
22	J. G. Weaver	Repairing furniture	106 75
29	......do	File-cases	250 00
31	Chronicle Publishing Company	Six months' subscription to Chronicle	5 00
Aug. 1	Hoff & Thomas	Miscellaneous	27 35
3	John C. Hogan	Awnings and repairs	55 00
3	S. M. Baldwin	Reports	3 00
3	E. J. Hayward	Washing towels	7 47
4	Atlantic and Pacific Telegraph Co	Telegrams	5 40
5	J. G. Weaver	Painting cases	60 00
5	Germond Crandell	Stationery	1 40
7	Adams Express Company	Freight	2 40

Statement of expenditures on account of the contingent fund, &c.—Continued.

Date.		From whom purchased.	Nature of purchases, &c.	Amount.
1876.				
Aug.	9	Herman Baumgarten	Dating stamp and brass dies	$17 00
	9	Mohun Bros	Stationery	139 00
	18	J. Bradley Adams	......do	51 50
	18	J. G. Weaver	Repairing furniture	137 48
	21	H. Baumgarten	Counter	4 00
	28	Western Union Telegraph Co	Telegrams	4 85
	29	E. M. Whittaker	Stationery	57 75
	30	E. C. Scidmore	Book-cases	60 00
Sept.	1	Robert Beall	Stationery	29 50
	1	Hoff & Thomas	Spittoons, wash-bowl, hair-brushes & combs	29 85
	5	E. J. Hayward	Washing towels	9 63
	6	J. G. Weaver	Two walnut window-cases	70 00
	8	Solomons & Chapman	Stationery	47 05
	9	Henry K. Cruit	Plumbing	77 43
	9	Lorenzo Rice	Cleaning carpets	106 40
	13	Adams Express Company	Expressage	36 25
	13	Atlantic and Pacific Telegraph Co.	Telegram	1 86
	14	L. H. Schneider	Blanks and locks	14 60
	25	W. H. Brereton	Ink-pads and ink	12 00
	27	Western Union Telegraph Co	Telegrams	5 56
	28	George Wooldridge	Chamois-skins, sponges, &c	39 00
	30	James Cooper	Paste	18 00
	30	John Markriter	Window-shades and fixtures, and repairs	38 80
	30	Hoff & Thomas	Miscellaneous	19 00
	30	Vernon Brothers	Stationery	161 75
	30	Great Falls Ice Company	Ice	152 88
Oct.	5	E. J. Hayward	Washing towels	7 17
	6	John Shelton	Cartage	1 50
	6	Adams Express Company	Expressage	38 90
	9	Solomons & Chapman	Stationery	683 44
	9	W. H. Dempsey	......do	186 78
	11	John G. Weaver	Making and repairing furniture	143 50
	12	William Ballantyne	Stationery	732 23
	13	Atlantic and Pacific Telegraph Co.	Telegrams	16 90
	14	Mohun Bros	Stationery	81 00
	14	John C. Hogan	Repairing awnings	29 00
	16	E. M. Whittaker	Atlas	20 00
	18	William S. Mitchell	Matting, oil-cloth, and mats	576 95
	21	John G. Weaver	Making and repairing furniture	74 80
	21	John Pitt	Transportation	75
	25	Western Union Telegraph Co	Telegrams	18 93
	26	W. S. Mitchell	Carpets	1,274 29
	28	H. N. Copp	United States Mining Decisions, 18 copies	76 50
	28	Julius Bien	Printing 3,000 copies Geographical Atlas	2,319 34
Nov.	1	Hoff & Thomas	Coal-hods, dust-brushes, and dust-pans	42 20
	1	Mohun Bros	Stationery	106 25
	2	John W. Jones	Expenses as special agent General Land Office.	263 80
	2	H. K. Cruit	Plumbing	49 44
	3	N. Cole	Express	40
	3	W. D. Wyvill	Repairing and resetting grates	101 00
	4	J. G. Weaver	Making and repairing furniture	53 75
	7	Adams Express Company	Expressage	6 30
	8	George H. Choate	Stationery	90 00
	14	E. Killpatrick	Expenses as special agent General Land Office.	286 94
	14	J. K. Walsh	......do	109 05
	15	W. W. Nottingham	Sawdust	9 00
	15	E. J. Hayward	Washing towels	6 78
	16	George Wooldridge	Hair-brushes and combs	30 00
	17	Alexander R. Shepherd & Co	Chandelier and globes	14 25
	18	Atlantic and Pacific Telegraph Co.	Telegrams	10 85
	21	Western Union Telegraph Co	......do	44 30
	21	G. N. Whittington	Horse-railroad tickets	30 00
	22	Robert Beall	Parchment paper	1,000 00
	24	M. M. Kaighn	Expenses as special agent General Land Office.	157 20
	25	J. G. Weaver	Making and repairing furniture	78 00
Dec.	4	Walter Allen	Mechanical Dictionary	6 00
	5	J. W. Boteler & Bro	Lamps, chimneys, and oil	36 50
	6	Adams Express Company	Freight	36 30
	8	E. J. Hayward	Washing towels	8 73
	8	Morgan Envelope Company	Stationery	55 20
	11	William Ballantyne	......do	20
	15	John Jones	Expenses as special agent General Land Office.	180 00
	16	J. G. Weaver	Making furniture	240 00
	19	D. McClelland	Printing and engraving	63 00
	26	George C. Maynard	Speaking-tubes, electric wires, and bells	154 00
	26	Western Union Telegraph Co	Telegrams	38 47

Statement of expenditures on account of the contingent fund, &c.—Continued.

Date.	From whom purchased.	Nature of purchases, &c.	Amount.
1876.			
Dec. 27	Franklin Telegraph Company	Telegrams	$3 65
27	Hoff & Thomas	Base-burner, hardware, &c	105 20
30	Alexander R. Shepherd & Co	Grates	193 90
31	W. H. Boyd	City Directory, 4 copies	20 00
31	Robert Beall	Stationery	23 00
31	James Cooper	Paste	18 00
31	J. G. Weaver	Making and repairing furniture	127 00
31	H. Baumgarten	Counter-die, retouching seal, and counter	15 00
31	W. B. Moses	Furniture	549 25
31	W. W. Farr	Repairing clocks and winding same	25 00
31	S. B. Linton	Map	10 00
31	Great Falls Ice Company	Ice	120 68
31	M. M. Kaighn	Expenses as special agent General Land Office.	311 10
31	C. W. Nash	do	168 00
31	Adams Express Company	Expressage	1 65
1877.			
Jan. 8	E. J. Hayward	Washing towels	6 72
9	John Markriter	Repairing shades	2 00
10	L. H. Schneider	Locks and blanks	2 99
11	J. G. Weaver	Making furniture	47 00
13	George W. Knox	Freight and cartage	5 50
13	John McDermott & Bro	Office truck	75 00
13	George Wooldridge	Miscellaneous	5 00
17	Mohun Bros	Stationery	301 57
17	Julius Bien	Cases for maps	5 00
18	Western Union Telegraph Co	Telegrams	5 09
18	J. G. Weaver	Repairing furniture	83 50
23	Atlantic and Pacific Telegraph Co.	Telegrams	11 85
23	do	do	3 60
23	Alexander R. Shepherd & Co	Wire fenders and grate-linings	61 75
24	C. Schneider	Hanging gong-bell	7 00
26	W. H. Dempsey	Stationery	383 80
27	B. Steele	Cartage	1 50
31	George F. Condron	do	4 25
31	Robert Beall	Ink	15 00
Feb. 1	Hoff & Thomas	Miscellaneous	19 90
1	Root & Co	Washington Chronicle	35
2	John W. Jones	Expenses as special agent General Land Office.	307 50
3	National Republican	One year's subscription to Daily Republican	8 00
3	J. G. Weaver	Making and repairing furniture	116 25
3	E. J. Hayward	Washing towels	10 38
5	C. W. Nash	Expenses as special agent General Land Office.	248 00
7	J. Disturnell	United States Register, 2 copies	3 00
8	Adams Express Company	Freight	16 85
8	Solomons & Chapman	Stationery	365 81
10	J. G. Weaver	Making and repairing furniture	82 00
13	J. B. Adams	Call-bells and twine	16 40
14	Mohun Bros	Stationery	298 05
16	W. S. Mitchell	Towels and cotton for maps	344 11
17	J. G. Weaver	Making and repairing furniture	100 75
17	John Markriter	Shade-fixtures and repairing shades	31 80
17	Randall Holmes	Cartage	1 50
19	James Edmunds	Copp's Land Owner, 3 volumes	3 00
20	Daniel T. Pierce	do	3 00
23	Alexander R. Shepherd	Repairing and setting grates	55 03
24	Robert Beall	Atlas and eyelet-machine	29 00
Mar. 2	J. G. Weaver	Repairing furniture and varnishing maps	274 75
3	John Markriter	Shade-tassels	18 00
3	Hoff & Thomas	Miscellaneous	18 50
7	E. J. Hayward	Washing towels	7 74
7	Solomons & Chapman	Stationery	160 36
8	E. A. Protois	Expenses as special agent General Land Office.	140 20
8	John W. Jones	do	238 00
8	Adams Express Company	Freight	16 70
10	J. G. Weaver	Varnishing and boxing maps	118 00
15	George Wooldridge	Hair-brushes	12 00
16	Samuel G. Young	Detergent	7 50
16	J. G. Weaver	Walnut desk, repairs, &c	222 90
17	J. Bradley Adams	Stationery	67 80
21	E. J. Smith	Bill-holder	121 20
24	J. G. Weaver	Making and repairing furniture	126 75
28	George Wooldridge	Sponges	12 25
29	Henry Copp	Copp's Land Owner, 3 sets	12 00
31	G. N. Whittington	Horse-railroad tickets	20 00
31	J. G. Weaver	Boxing and shipping maps	183 00
31	Julius Bien	Packing cases	21 00

Statement of expenditures on account of the contingent fund, &c.—Continued.

Date.		From whom purchased.	Nature of purchases, &c.	Amount.
1877.				
Mar.	31	W. H. Walker	Magnifying glasses	$12 00
	31	James Cooper	Paste	18 00
	31	Great Falls Ice Company	Ice	106 80
	31	Hoff & Thomas	Miscellaneous	25 35
	31	George C. Maynard	Speaking-tube whistle and battery	2 25
Apr.	6	Adams Express Company	Freight	160 60
	7	J. G. Weaver	Repairing furniture	92 25
	7	Vernon Brothers	Stationery	28 75
	9	Mohun Brothers	......do	42 80
	9	Baltimore and Potomac Railroad Co.	Freight	28 88
	11	C. W. Nash	Expenses as special agent General Land Office.	224 00
	11	John W. Jones	......do	188 55
	12	Atlantic and Pacific Telegraph Co.	Telegrams	9 24
	17	Julius Bien	Stationery	34 50
	18	Mohun Brothers	......do	489 66
	18	M. A. Carter	Expenses as special agent General Land Office.	94 00
	18	Henry N. Copp	Copp's Land Owner, 130 copies	12 50
	18	C. W. Nash	Expenses as special agent General Land Office.	248 00
	19	M. A. Carter	......do	60 50
	21	J. G. Weaver	Repairing furniture	30 25
	23	Columbian Bank Note Company	Engraving scrip certificates	585 00
	24	Hoff & Thomas	Miscellaneous	42 35
	25	T. H. Hamersley	Reports	20 00
	28	J. G. Weaver	File cases	62 50
	28	John Markriter	Shade fixtures	4 60
	28	John C. Hogan	Repairing and putting up awnings	88 80
	30	Herman Baumgarten	Seal and counter die	25 00
	30	T. H. Hamersley	Land Office Reports	15 00
May	2	E. J. Hayward	Washing towels	15 70
	4	S. R. Edwards	Expenses as special agent General Land Office.	66 91
	4	Alexander R. Shepherd & Co	Grate	13 40
	5	J. G. Weaver	Making and repairing furniture	48 50
	5	Mohun Brothers	Stationery	48 00
	7	Harmon, Boswell & Co	Walnut chair	8 50
	7	Henry N. Copp	Land Owner, 130 copies	12 50
	8	W. D. Smith	Copp's Land Owner, 1 volume	1 00
	8	J. W. Bixler	Copp's Land Owner, 3 volumes	3 00
	8	L. Harrison	......do	3 00
	10	Solomons & Chapman	Stationery	137 65
	11	E. A. Protois	Expenses as special agent General Land Office.	173 25
	11	......do	......do	97 00
	11	Robert Beall	Stationery	5 50
	12	J. G. Weaver	Making and repairing furniture	75 25
	14	G. W. Knox	Freight and cartage	11 63
	14	A. S. Barnes	A year's subscription to International Review	5 00
	16	Western Union Telegraph Co	Telegrams	10 46
	16	......do	......do	14 30
	16	W. H. & O. H. Morrison	Law book	6 00
	17	S. G. Young	Detergent	7 50
	17	W. W. Nottingham	Sawdust	8 55
	18	J. Bradley Adams	Stationery	119 02
	21	William S. Mitchell	Cotton and rollers for maps	523 67
	22	Atlantic and Pacific Telegraph Co.	Telegrams	5 90
	24	George Wooldridge	Miscellaneous	19 00
	26	J. G. Weaver	Making and repairing furniture	104 96
	28	J. P. Libbey	Miscellaneous	5 50
	31	Chicago Tribune Company	One year's subscription to Daily Tribune	14 50
June	1	George C. Maynard	Work on wires and batteries	2 25
	2	J. G. Weaver	Making and repairing furniture	20 00
	4	E. J. Hayward	Washing towels	9 93
	4	Henry N. Copp	Copp's Land Owner	12 50
	4	Robert Beall	Stationery	100 10
	5	S. R. Edwards	Expenses as special agent Pension Office	59 00
	6	National Railway Publishing Co	Railway Guide	1 00
	6	Hoff & Thomas	Miscellaneous	24 60
	7	Adams Express Company	Freight	3 15
	7	J. B. Adams	Six months' subscription to New York Tribune.	7 50
	9	J. G. Weaver	Making and repairing furniture	107 80
	12	Franklin Telegraph Company	Telegrams	8 51
	12	Western Union Telegraph Co	......do	29 13
	13	E. Carstens	Painting	300 00
	15	John Markriter	Shade-fixtures	4 40
	16	J. G. Weaver	Repairing furniture	25 00
	16	John C. Hogan	Awnings, &c	23 00

Statement of expenditures on account of the contingent fund, &c.—Continued.

Date.	From whom purchased.	Nature of purchases, &c.	Amount.
1877.			
June 16	Mohun Brothers	Stationery	$38 50
20	H. O. Towles	Walnut desks and chairs	201 00
21	E. Carstens	Painting	98 50
22	Hoff & Thomas	Miscellaneous	58 90
23	J. G. Weaver	Making and repairing furniture	69 83
25	Reissner & Jenks	Water-cooler	6 50
26	W. P. Moses	Walnut chairs	63 50
26	H. O. Towles	Chairs and wash-stand	37 00
27	John C. Hogan	Awnings	18 00
27	J. P. Libbey	Ice-pitcher	14 75
28	W. S. Mitchell	Matting and oil-cloth	689 45
29	George W. Knox	Cartage	50
30	J. G. Weaver	Making case	140 00
30	A. R. Shepherd & Co	Grates, linings, &c	89 55
30	James Cooper	Paste	18 00
30	James S. Topham	Leather bag	18 00
30	Charles Fischer	Repairing fasteners	1 75
30	S. R. Edwards	Expenses as special agent General Land Office.	63 00
30	H. N. Copp	Copp's Land Owner	12 50
30	Great Falls Ice Company	Ice	107 80
30	J. P. Bansman	Expenses as special agent General Land Office.	110 34
30	E. J. Hayward	Washing towels	8 22
30	J. W. Boteler & Bro	Crockery	5 50
30	Atlantic and Pacific Telegraph Co	Telegrams	12 04
30	Mohun Brothers	Stationery	19 00
30	G. N. Whittington	Horse-railroad tickets	30 00
30	J. G. Weaver	Making and repairing furniture	166 25
30	Western Union Telegraph Co	Telegrams	27 08
30	John Markriter	Shade fixtures	8 55
26	W. H. Dempsey	Stationery	112 80
July 14	J. G. Weaver	Making and repairing furniture	364 40
16	M. A. Carter	Expenses as special agent General Land Office.	103 75
Aug. 1	Julius Bien	Furnishing maps of States and Territories	740 20
10	C. W. Nash	Expenses as special agent General Land Office.	186 80
8	G. W. & C. B. Colton & Co	One commercial map of the United States	15 00
Sept. 5	George K. Bradford	Expenses as special agent General Land Office.	75 00
	Amount expended		27,449 85
	Balance on hand unexpended		50 15
	Amount appropriated		27,500 00

Statement of expenditures on account of the contingent fund of the United States Pension Office for the fiscal year ending June 30, 1877.

Date.	From whom purchased.	Nature of purchases, &c.	Amount.
1876.			
July 15	M. T. Parker	Painting sign	$2 50
20	Walter D. Vaughn	Caning chairs	4 25
22	John H. Wager	Special service	53 40
24	Henry Elliott	Carting	2 00
31	Jno. H. Wager	Special service	36 15
Aug. 3	E. R. Hutchins	do	87 62
3	J. S. Topham	Repairing mail-bag	2 00
3	E. J. Hayward	Washing towels	25 14
4	Atlantic and Pacific Telegraph Co.	Telegraphing	1 25
4	M. E. Jenks	Special service	107 87
4	Robert Clarke	do	67 15
5	W. De Vaughn	Caning chairs	1 25
5	Washington Gas Light Company	Gas	68 18
5	D. I. Murphy	Special service	123 73
5	R. R. Shopp	do	117 03
7	H. P. Leech	do	4 25
9	Henry Elliott	Carting	2 00
9	Washington and Georgetown Railroad Company.	Car tickets	10 00
9	Metropolitan Railroad Company	do	10 00
9	R. L. Smith	Special service	191 20

Statement of expenditures on account of the contingent fund, &c.—Continued.

Date.	From whom purchased.	Nature of purchases, &c.	Amount.
1876.			
Aug. 9	Adams Express Company	Expressage	$5 15
10	John Moran	Repairing water-coolers, &c	6 00
10	I. B. Dunn	Special service	130 26
10	R. W. Furnas	......do	81 00
10	T. P. Kane	......do	31 11
10	E. R. Hutchins	......do	110 95
10	J. C. Aylesworth	......do	103 55
11	James H. Clements	......do	118 50
12	W. De Vaughn	Caning chairs	2 50
14	Mohun Bros	Stationery	81 30
16	T. P. Kane	Special service	45 49
17	J. H. Wager	......do	92 47
19	Alex. Hull	......do	44 90
21	H. C. Elliott	Cartage	2 00
22	A. F. Kingsley	Special service	8 75
28	Gustav Clemen	......do	138 80
28	R. W. Furnas	......do	78 05
29	Alex. Hall	......do	130 30
30	Metropolitan Railroad Company	Car-tickets	5 00
30	Washington and Georgetown Railroad Company.	......do	15 00
30	Elmer H. Craig	Special service	122 30
30	T. Lanston	......do	16 23
31	J. C. Aylesworth	......do	76 00
31	A. F. Kingsley	......do	11 75
Sept. 1	Henry Hall	Freight	1 00
4	J. F. Cole & Co	Sundries	8 50
5	E. J. Hayward	Washing towels	23 22
6	Washington Gas-Light Company	Gas	60 53
7	John H. Wager	Special service	86 70
7	M. E. Jenks	......do	120 85
7	R. W. Furnas	......do	195 25
7	D. I. Murphy	......do	160 46
7	Benjamin F. Shopp	......do	122 72
7	Isaac W. Vrooman	......do	52 10
7	......do	......do	57 60
7	......do	......do	61 30
7	H. R. McCalmont	......do	22 60
7	G. H. Ragsdale	......do	173 40
9	Robert Clarke	......do	49 70
14	Mohun Brothers	Stationery	905 95
15	E. H. Craig	Special service	176 50
15	Gustav Clemen	......do	131 60
15	Isaac W. Vrooman	......do	29 00
15	Alex. Hull	......do	63 94
15	James H. Clements	......do	125 75
15	Isaac B. Dunn	......do	158 10
20	E. R. Hutchins	......do	187 17
20	H. J. Hart	Insect powder	74 85
23	G. A. L. Merrifield	Special service	81 00
26	P. Fleming	Horse-hire	60 00
26	Adams Express Company	Express	2 60
27	W. H. Dempsey	Stationery	599 10
27	Western Union Telegraph Co	Telegraphing	31 88
28	C. H. McCathran	Mounting maps	8 25
28	Alex. R. Shepherd	Heating Pension Office	1,230 00
30	Western Union Telegraph Co	Telegraphing	6 47
30	E. R. Hutchins	Special service	97 22
30	John A. Darling	......do	71 62
30	John H. Benton	......do	35 10
30	Webb & Beveridge	Spittoons	10 50
30	M. Judd	Clock (repairing)	1 50
30	Great Falls Ice Company	Ice	284 80
30	R. L. Smith	Special agent	153 85
Oct. 5	Henry Elliott	Carting	3 00
5	J. C. Aylsworth	Special service	95 61
5	J. H. Wager	......do	138 95
5	C. Myers	......do	69 16
5	Benjamin R. Shopp	......do	105 96
5	E. J. Hayward	Washing towels	11 10
5	Metropolitan Railroad Company	Car-tickets	5 00
5	Washington and Georgetown Railroad Company.	......do	10 00
5	Isaac B. Dunn	Special service	150 52
6	Webb & Beveridge	Basin and pitcher, &c	5 00
6	Frank W. Poor	Special service	196 23
6	W. F. Eaton	......do	73 47
6	B. W. Reed & Sons	Baskets, sponges, and sundries	49 81
6	H. P. Leech	Special service	120 94
6	A. Hull	......do	39 61

Statement of expenditures on account of the contingent fund, &c.—Continued.

Date.	From whom purchased.	Nature of purchases, &c.	Amount.
1876.			
Oct. 7	Christian Exel	Special service	$72 15
7	M. E. Jenks	......do	124 79
7	James H. Clements	......do	101 50
7	George W. Ragsdale	......do	12 00
7	......do	......do	140 55
7	J. Bradley Adams	Stationery	646 50
7	Adams Express Company	Express	6 40
7	Washington Gas-Light Company	Gas	63 45
9	H. R. McCalmont	Special service	129 05
9	Chronicle Publishing Company	Newspaper	2 25
10	Elmer H. Craig	Special service	165 20
10	D. L. Smith	......do	174 70
12	Dana, Parks & Co	Blinds and fixtures	14 00
12	L. H. Schneider	Hardware	26 93
13	Atlantic and Pacific Telegraph Co	Telegraph	11 91
13	......do	......do	2 05
14	J. A. Darling	Special service	45 13
16	M. G. Copeland	Awnings	323 00
16	Gustav Clemen	Special service	115 48
17	Alonzo Weeks	......do	86 00
18	J. W. Vrooman	......do	153 48
18	H. P. Leech	......do	63 80
19	C. R. Conner	......do	160 05
19	C. Exel	......do	50 23
20	W. H. Orton	Gold lettering	37 50
21	D. I. Murphy	Special service	143 39
21	C. Myers	......do	54 50
23	Robert McMurray	Document straps	52 08
24	P. Fleming	Livery	168 00
25	Western Union Telegraph Co	Telegraphing	23 67
27	E. R. Hutchins	Special service	7 93
27	George C. Maynard	Moving telegraph, &c	85 00
31	W. B. Moses	Furniture	2,356 08
31	John H. Wager	Special service	48 35
Nov. 2	F. H. Sprague	......do	208 65
3	A. R. Shepherd & Co	Heating Pension Office	60 42
3	W. H. Hutchinson	Special service	114 70
4	D. I. Murphy	......do	147 28
4	Benjamin R. Shopp	......do	107 25
4	W. F. Eaton	......do	108 52
6	Robert Beall	Books	14 50
6	Isaac W. Vrooman	Special service	93 50
6	M. E. Jenks	......do	107 03
6	Gas Company	Gas	5 63
7	T. B. Hood	Special service	21 50
8	James H. Clements	......do	92 50
8	Isaac B. Dunn	......do	92 90
8	H. P. Leech	......do	106 00
8	J. C. Aylesworth	......do	133 40
8	Elmer H. Craig	......do	178 66
8	George H. Ragsdale	......do	141 75
9	M. G. Copeland	Awnings	85 00
9	J. H. Hobbs	Special service	49 05
10	Tolbert Lanston	......do	177 70
11	E. M. Whittaker	Stationery	704 23
11	John H. Wager	Special service	110 55
11	R. L. Smith	......do	185 65
11	E. E. Fuller	......do	100 27
13	John H. Benton	......do	196 05
14	J. B. G. Baxter	......do	262 55
14	W. H. Webster	......do	113 86
14	W. E. Dulin	......do	85 40
14	F. D. Stephenson	......do	91 50
14	M. T. Parker	Varnishing case	1 00
15	C. W. Mullaly	Special service	116 20
15	John G. Olberg	......do	26 50
15	J. W. McMillan	......do	129 30
15	H. R. McCalmont	......do	152 23
15	James P. Scott	......do	50 55
15	E. J. Hayward	Washing towels	8 58
15	H. Baumgarten	Hand-stamp	10 00
17	J. A. Macauley	Special service	145 92
17	Thomas W. Smith	Lumber	65 18
18	Metropolitan Railroad Company	Car-tickets	5 00
18	Washington and Georgetown Railroad Company.	......do	15 00
20	William Balantyne	Straps and ink	5 96
20	Gustav Clemen	Special service	112 76
21	Western Union Telegraph Co	Telegraphing	17 92
21	John M. Comstock	Special service	108 87

Statement of expenditures on account of the contingent fund, &c.—Continued.

Date.	From whom purchased.	Nature of purchases, &c.	Amount.
1876.			
Nov. 21	H. Baumgarten	Preparing stamps	23 00
21	Riggles & Hopkins	Stationery	10 00
22	Frank Hodges	Special service	64 55
22	J. W. McMillan	......do	23 00
22	L. Holtzlander	......do	118 45
23	S. C. McCandless	Copies of records	6 50
23	John G. Olberg	Special service	20 30
24	John C. Parker	Newspapers	16 00
24	W. C. Orton	Glass sign	2 50
24	J. W. Boteler & Bro	Baskets	8 25
27	Isaac B. Dunn	Special service	111 12
28	Paul E. Williams	......do	153 60
28	J. W. Morris	......do	103 99
29	A. F. Kingsley	......do	19 29
29	Frank Hodges	......do	4 25
29	G. W. Frost	......do	52 31
29	M. E. Jenks	......do	124 85
29	N. F. Graham	......do	118 50
Dec. 2	J. P. Libbey	Repairing clock	1 50
2	Henry Pinckney	Carting	2 75
4	Alexander R. Shepherd & Co	Heating Pension Office	60 42
4	P. H. Berkan	Special service	203 35
5	Alexander R. Shepherd & Co	Fixtures, fittings, &c	544 02
5	Benjamin R. Shopp	Special service	106 63
5	W. F. Eaton	......do	95 88
5	D. I. Murphy	......do	72 09
6	J. D. Smith	......do	29 60
6	......do	......do	156 81
7	Solomons & Chapman	Stationery	357 40
7	Elmer H. Craig	Special service	109 10
7	J. H. Clements	......do	136 45
8	E. J. Hayward	Washing towels	12 36
8	Washington Gas-Light Company	Gas	48 38
9	T. B. Hood	Special service	33 60
9	O. B. Bloss	Searching records, &c	19 88
9	Robert Beall	Ink	10 00
9	Morgan Envelope Company	Envelopes	2,063 43
11	H. P. Leech	Special service	14 30
11	J. H. Wager	......do	131 95
11	George H. Ragsdale	......do	142 55
11	E. R. Hutchins	......do	100 20
11	R. L. Smith	......do	91 30
12	Atlantic and Pacific Telegraph Co	Telegraphing	2 36
12	......do	......do	2 22
12	George Wooldridge	Hair brushes and combs	13 35
12	G. S. Thompson	Special service	112 87
13	Bureau of Engraving and Printing	Engraving and printing	46 03
14	John Des Rocliers	Ink extractor	8 00
16	R. H. McMurray	Leather straps	37 48
16	J. C. Aylesworth	Special service	93 68
16	Metropolitan Railroad Company	Car-tickets	5 00
16	Washington and Georgetown Railroad Company.	......do	15 00
18	O. N. Miller	Special service	94 30
19	C. M. Tompkins	......do	142 59
19	H. R. McCalmont	......do	130 91
20	Isaac B. Dunn	......do	85 60
20	George H. Ragsdale	......do	85 50
21	T. Lanston	......do	15 17
21	Gustav Clemen	......do	97 00
21	George W. Richards	......do	136 25
22	C. M. Tompkins	......do	6 25
23	Henry Pinckney	Carting	5 00
26	Alexander R. Shepherd	Heating Pension Office	60 42
26	Walter De Vaughn	Caning chairs	3 75
26	Western Union Telegraph Co	Telegraphing	5 37
26	E. R. Hutchins	Special service	38 18
27	J. C. Aylesworth	......do	78 14
28	Albert Deyo	Copy of divorce	1 00
28	William S. Mitchell	Cleaning carpets	65 10
28	Tucker & Sherman	Lumber	9 44
30	A. F. Kingsley	Special service	30 57
30	John G. Olberg	......do	59 75
30	Phelon Robinson	Carting	1 00
30	Walter De Vaughn	Caning chairs	5 00
30	W. F. Eaton	Special service	108 43
30	W. B. Moses	Furniture	236 78
30	M. E. Jenks	Special service	112 90
30	Benjamin R. Shopp	......do	101 70
30	F. H. Sprague	......do	103 88
30	Great Falls Ice Company	Ice	89 32

Statement of expenditures on account of the contingent fund, &c.—Continued.

Date.	From whom purchased.	Nature of purchases, &c.	Amount.
1876.			
Dec. 30	Robert Beall	Pincushions	$8 25
30	Root & Co	Newspaper	1 00
30	B. Morse	Copy of will	2 00
30	B. W. Reed's Sons	Sundries	20 92
30	John M. Welty	Special service	89 69
30	J. A. Macauley	......do	89 63
30	Washington Gas-Light Company	Gas	94 50
30	William H. Boyd	City Directory	30 00
1877.			
Jan. 8	D. I. Murphy	Special service	117 52
8	John H. Benton	......do	74 80
8	E. J. Hayward	Washing towels	9 24
8	E. H. Craig	Special service	194 45
8	E. R. Hutchins	......do	70 45
8	H. P. Leech	......do	130 70
8	Washington and Georgetown Railroad Company.	Car tickets	10 00
8	Columbia Railroad Company	......do	5 00
8	Metropolitan Railroad Company	......do	5 00
10	John H. Wager	Special service	153 85
10	Isaac B. Dunn	......do	81 24
10	O. N. Miller	......do	112 85
10	Adams Express Company	Express	2 00
10	Daniel Smith	Lumber	34 80
11	Herman Baumgarten	Repairing stamps	14 50
11	Walter De Vaughn	Caning chairs	2 50
11	Webb & Beveridge	Wash-bowl, pitcher, &c	3 45
12	L. H. Schneider	Hardware	65 76
12	R. L. Smith	Special service	46 50
12	J. H. Clements	......do	147 40
13	Tucker & Sherman	Doors	8 00
13	George W. Richards	Special service	25 00
17	W. De Vaughn	Caning chairs	2 50
17	Bureau Engraving and Printing	Engraving and printing	318 42
17	Edgar Weeks	Certified copies	1 75
18	Western Union Telegraph Co	Telegraphing	16 33
19	C. R. Conner	Special service	90 80
19	J. R. Van Mater	......do	42 00
22	Alexander R. Shepherd & Co	Fittings, &c	81 35
23	George H. Ragsdale	Special service	98 65
23	E. R. Hutchins	......do	77 06
27	H. R. McCalmont	......do	101 80
27	T. B. Hood	......do	28 87
27	Topographer Post-Office Department.	Mounting maps	27 75
29	Alexander R. Shepherd & Co	Heating Pension Office	60 42
30	Walter De Vaughn	Caning chairs	2 50
31	Washington and Georgetown Railroad Company.	Car tickets	12 00
31	Belt Line Railroad Company	......do	3 00
31	Metropolitan Railroad Company	......do	5 00
Feb. 2	Henry Pinckney	Carting	11 75
2	E. M. Whittaker	Straw	3 68
3	E. J. Hayward	Washing towels	10 38
3	M. E. Jenks	Special service	139 61
3	T. D. Yeager	......do	42 29
3	D. I. Murphy	......do	108 81
5	John H. Benton	......do	107 33
6	H. P. Leech	......do	132 81
6	T. L. Fracker	......do	64 95
6	F. H. Sprague	......do	128 00
6	W. F. Eaton	......do	127 05
6	Benjamin R. Shopp	......do	102 72
6	Isaac B. Dunn	......do	38 50
8	Washington Gas Company	Gas	101 25
8	John W. Wheeler	Special service	49 43
8	Elmer H. Craig	......do	190 85
8	O. N. Miller	......do	132 90
8	John H. Wager	......do	92 00
8	J. M. Welty	......do	124 60
8	George H. Ragsdale	......do	58 70
8	Isaac H. Vrooman	......do	77 30
8	A. S. Coleman	......do	39 71
8	Joseph Carr	......do	51 88
[illegible]	J. A. Macauley	......do	104 67
[illegible]	John Edwin Mason	......do	41 30
[illegible]	J. W. Morris	......do	5 50
[illegible]	C. R. Conner	......do	103 40
[illegible]	George W. Richards	......do	110 00
[illegible]	J. H. Clements	......do	154 90
[illegible]	C. W. Mallaly	......do	55 70

Statement of expenditures on account of the contingent fund, &c.—Continued.

Date.	From whom purchased.	Nature of purchases, &c.	Amount.
1877.			
Feb. 14	Gustav Clemen	Special service	$118 10
14	Franklin Wood	......do	57 30
15	Walter De Vaughn	Caning chairs	1 25
16	Charles Lucas	Mending mail-bag	1 00
16	J. H. Hobbs	Special service	50 40
17	E. R. Hutchins	......do	105 50
22	H. P. Leech	......do	83 05
22	C. W. Mullaly	......do	73 61
22	D. J. Waters	......do	77 56
24	H. R. McCalmont	......do	90 97
26	E. R. Hutchins	......do	34 25
26	......do	......do	89 55
Mar. 2	M. E. Jenks	......do	123 69
2	A. S. Coleman	......do	135 89
2	F. H. Sprague	......do	103 26
2	Elmer H. Craig	......do	177 65
2	T. D. Yeager	......do	99 77
6	W. F. Eaton	......do	98 06
6	Franklin Wood	......do	126 60
7	John H. Benton	......do	128 34
7	J. W. Wheeler	......do	103 40
7	H. P. Leech	......do	69 00
7	G. H. Ragsdale	......do	110 55
7	Isaac B. Dunn	......do	97 45
9	Joseph Carr	......do	111 09
9	J. M. Welty	......do	81 00
9	John H. Wager	......do	127 40
9	N. B. Vineyard	......do	55 10
9	O. N. Miller	......do	127 40
9	Benjamin R. Shopp	......do	101 37
9	Frank A. Wordell	......do	65 30
10	Alexander R. Shepherd	Heating Pension Office	60 42
10	C. R. Conner	Special service	143 85
10	Gustav Clemen	......do	109 25
10	......do	......do	140 45
12	D. I. Murphy	......do	87 76
12	C. W. Mullaly	......do	111 21
13	D. J. Waters	......do	66 97
13	National Republican	Newspaper	8 00
14	T. L. Fracker	Special service	95 85
15	Root & Co	Newspaper	35
15	Alexander R. Shepherd & Co	Plumbing	6 35
15	......do	Repairing radiator	2 75
15	J. H. Clements	Special service	131 55
15	J. A. Macauley	......do	93 49
15	W. R. Bates	......do	43 85
15	Metropolitan Railroad Company	Car tickets	5 00
15	Washington and Georgetown Railroad Company.	......do	10 00
15	John Edwin Mason	Special service	167 45
16	Samuel G. Young	Detergent	7 50
16	John W. Wheeler	Special service	67 10
16	Adams Express Company	Express	1 10
17	Washington Gas-Light Company	Gas	92 25
17	Robert Beall	Ink	5 00
19	George Ryneal	Painting material	31 96
20	A. S. Coleman	Special service	81 81
21	J. Disturnell	Registers	3 00
21	J. W. Boteler & Bro	Sundries	11 83
21	Estate F. S. Gathier, deceased	Concentrated lye	1 00
22	H. P. Leech	Special service	74 25
22	George W. Richards	......do	82 80
23	Atlantic and Pacific Telegraph Co.	Telegraphing	1 01
24	William M. Shuster & Bro	Towels	21 25
24	Perry Bros	......do	26 25
24	Western Union Telegraph Co	Telegraphing	19 79
24	......do	......do	7 96
24	G. W. Wormelle	Special service	49 40
24	Isaac B. Dunn	......do	92 40
24	T. Edward Clarke & Co	Lumber	16 61
26	G. W. Wormelle	Special service	102 35
26	Bureau Engraving and Printing	Engraving and printing	315 80
26	......do	......do	117 43
28	Alexander R. Shepherd	Heating Pension Office	60 42
29	H. R. McCalmont	Special service	79 65
30	J. G. Bates	Cleaning clock	5 00
30	J. H. Hobbs	Special service	105 00
31	Alexander R. Shepherd & Co	Fixtures	61 70
31	D. W. Beveridge	Repairing elevator	15 00
31	J. D. Yeager	Special service	123 59

Statement of expenditures on account of the contingent fund, &c.—Continued.

Date.	From whom purchased.	Nature of purchases, &c.	Amount.
1877.			
Mar. 31	W. F. Eaton	Special service	$113 88
31	Henry Pinckney	Carting	7 50
31	N. J. Riddick	Transcript of records	17 21
31	F. H. Sprague	Special service	114 93
31	Franklin Wood	do	132 45
31	D. I. Murphy	do	136 98
31	M. E. Jenks	do	118 23
31	B. W. Reed's Sons	Sundries	4 60
31	T. L. Fracker	Special service	20 00
31	do	do	117 20
Apr. 6	B. W. Reed's Sons	Sponges	15 75
6	Adams Express Company	Express	3 05
6	N. B. Vineyard	Special service	141 70
6	Benjamin R. Shopp	do	126 93
6	E. H. Craig	do	76 79
6	J. H. Ragsdale	do	143 30
6	F. A. Wordell	do	126 77
7	R. McMurray	Leather straps	66 92
7	Samuel Hurdle	Masonry	5 00
7	Robert Beall	Ink	10 00
7	A. S. Coleman	Special service	34 65
7	Isaac B. Dunn	do	49 55
7	A. W. Fisher	do	84 30
7	J. E. Mason	do	106 15
7	J. H. Wager	do	148 85
7	O. N. Miller	do	124 60
7	Riggles & Hopkins	Sundries	5 80
7	J. M. Welty	Special service	53 59
7	Washington Gas-Light Company	Gas	87 75
9	H. Baumgarten	Stamps (hand)	40 00
9	Mohun Bros	Stationery	107 61
9	A. F. Kingsley	Special service	33 60
9	J. H. Benton	do	79 23
10	H. P. Leech	do	71 00
10	C. R. Conner	do	137 55
11	W. R. Bates	do	88 85
12	T. Edward Clarke & Co	Lumber	62 65
12	Franklin & Co	Magnifying-glass	2 50
14	Great Falls Ice Company	Ice	59 08
14	T. Edward Clarke	Lumber	35 00
14	J. A. Macauley	Special service	121 06
14	E. R. Hutchins	do	7 50
14	Joseph Carr	do	141 65
16	W. B. Moses	Furniture	809 18
16	Gustav Clemen	Special service	97 99
21	W. E. Dulin	do	64 36
21	W. L. Nicholson	Mounting maps	22 00
23	J. Bradley Adams	Pincushions	9 00
23	H. P. Leech	Special service	76 50
25	L. A. Brandebury	do	59 60
26	Phelin Robinson	Carting	2 50
26	A. S. Coleman	Special service	118 31
30	M. E. Jenks	do	162 67
May 2	E. J. Hayward	Washing towels	43 93
3	A. H. Chase	Leather cushion	6 50
3	Henry Pinckney	Carting	3 75
4	F. H. Sprague	Special service	117 92
4	John H. Benton	do	103 66
4	W. F. Eaton	do	99 15
5	Washington Gas-Light Company	Gas	76 50
5	Benjamin R. Shopp	Special service	110 99
5	Joseph Carr	do	121 87
5	H. R. McCalmont	do	118 64
5	J. R. Van Mater	do	29 09
5	William Ballantyne	Books and sundries	28 56
7	H. P. Leech	Special service	86 75
7	Frank A. Wordell	do	157 50
7	Joseph Loughran	do	137 05
7	D. B. Johnson	do	48 00
7	D. I Murphy	do	95 90
7	John Edwin Mason	do	132 70
7	J. W. Morris	do	100 05
7	N. B. Vineyard	do	123 10
7	I. B. Dunn	do	147 10
7	J. H. Clements	do	110 55
7	Franklin Wood	do	150 13
9	L. A. Brandebury	do	69 20
9	John H. Wager	do	142 55
9	A. Vangender	do	136 30
9	A. W. Fisher	do	126 55

Statement of expenditures on account of the contingent fund, &c.—Continued.

Date.	From whom purchased.	Nature of purchases, &c.	Amount.
1877.			
May 9	O. N. Miller	Special service	$120 40
9	George H. Ragsdale	......do	145 15
9	Charles R. Conner	......do	128 35
10	Metropolitan Railroad Company	Car tickets	5 00
10	Belt Line Railroad Company	......do	5 00
11	George W. Richards	Special service	66 90
12	A. S. Coleman	......do	52 84
14	C. W. Thorn	Brushes and combs	15 25
15	Anna F. Craig	Scrap-books	21 00
15	W. De Vaughn	Caning chairs	5 00
15	George W. Richards	Special service	38 25
16	Western Union Telegraph Co	Telegraphing	15 65
16	......do	......do	15 46
17	H. R. McCalmont	Special service	119 80
17	D. B. Johnson	......do	46 42
18	J. A. Macauley	......do	114 92
18	Elmer H. Craig	......do	141 94
21	Frank A. Wordell	......do	91 12
22	Atlantic and Pacific Telegraph Co.	Telegraphing	81
22	John M. Welty	Special service	26 55
22	J. A. Bentley	......do	50 00
24	Isaac B. Dunn	......do	68 50
25	William Tyrell	Services in moving	6 75
25	Benjamin Robinson	......do	6 75
25	Charles Peters	......do	6 75
25	James Bradford	......do	6 75
25	Thomas Frazier	......do	6 00
25	Harrison Ward	......do	6 00
25	William Swink	......do	6 00
25	Robert Carter	......do	6 00
25	Moses Robinson	......do	6 00
25	Manuel Webb	......do	6 00
25	W. H. Cushman	Special service	47 31
26	C. R. Conner	......do	165 15
28	W. R. Bates	......do	80 35
28	C. F. Sawyer	......do	69 75
28	Walter De Vaughn	Caning chairs	1 25
29	A. Vangender	Special service	153 25
31	Riggles & Hopkins	Sundries	4 00
31	G. W. Odlum	Special service	13 10
June 2	W. E. Dulin	......do	9 85
2	Henry Pinkney	Carting	3 00
2	M. G. Cokeland	Awnings	76 00
2	George W. Richards	Special service	71 30
4	E. J. Hayward	Washing towels	11 88
5	George W. Knox	Carting	24 00
5	A. S. Coleman	Special service	78 77
5	W. F. Eaton	......do	127 96
5	F. H. Sprague	......do	150 81
5	John H. Benton	......do	145 25
6	R. Leitch & Son	Pipe and fittings	2 50
6	W. H. Cushman	Special agent	118 90
7	George W. Odlum	......do	32 34
7	H. P. Leech	......do	139 67
7	George H. Ragsdale	......do	123 60
7	N. B. Vineyard	......do	147 05
7	F. A. Wordell	......do	86 45
7	M. E. Jenks	......do	212 92
7	L. A. Brandebury	......do	147 53
7	John H. Wager	......do	177 95
7	Joseph Loughran	......do	169 00
7	J. W. Morris	......do	131 34
7	L. H. Schneider	Hardware	86 03
7	T. Edward Clarke & Co	Lumber	7 68
7	Washington and Georgetown Railroad Company.	Car tickets	5 00
7	Washington Gas Company	Gas	67 95
7	Adams Express Company	Express	6 45
8	W. R. Bates	Special service	94 15
8	E. H. Craig	......do	159 47
8	I. B. Dunn	......do	84 90
8	B. R. Shopp	......do	122 73
8	John E. Mason	......do	146 98
8	Joseph Carr	......do	155 70
8	O. N. Miller	......do	130 85
8	A. Shepherd	......do	86 82
8	Franklin Wood	......do	170 16
9	D. I. Murphy	......do	106 23
11	George Ryneal, jr	Glass, putty, &c	21 87
11	James H. Clements	Special service	182 35

Statement of expenditures on account of the contingent fund, &c.—Continued.

Date.	From whom purchased.	Nature of purchases, &c.	Amount.
1877.			
June 12	Western Union Telegraph Co.	Telegraphing	$41 91
12	Franklin Telegraph Company	......do	50
13	J. H. Benton	Special service	56 74
13	George W. Richards	......do	54 17
13	J. A. Macauley	......do	157 90
13	A. F. Kingsley	......do	10 69
14	H. Baumgarten	Rubber stamps	5 00
15	G. W. Odlum	Special service	34 89
16	H. R. McCalmont	......do	115 65
16	Mohun Brothers	Gold pen and holder	4 00
16	......do	Eyelet bore	1 50
16	A. W. Fisher	Special service	80 10
16	......do	......do	182 20
18	M. E. Jenks	......do	147 40
19	Daniel Smith	Tile boards	30 80
21	J. H. Wager	Special service	78 65
21	F. A. Wordell	......do	57 60
22	J. H. Benton	......do	136 65
22	Alex. R. Shepherd & Co.	Fittings, &c	90 48
23	George W. Richards	Special service	16 00
25	Robert Graham	Carriage for Commissioner	550 00
26	Isaac B. Dunn	Special service	118 95
26	W. T. Van Doren, jr	......do	112 40
26	George W. Frost	......do	69 00
27	W. H. Slater	Horse	160 00
28	H. L. Pelouze & Son	Rollers for printing-press	3 00
28	.....do	Bracket for printing-press	1 50
28	R. McMurray	Document straps	24 00
29	B. R. Shopp	Special service	112 23
30	George W. Richards	......do	37 04
30	V. Lammond	Caning chairs	3 75
30	W. F. Eaton	Special service	73 44
30	W. H. Cushman	......do	118 85
30	A. Brown	Horseshoes	2 00
30	J. D. Smith	Special service	47 08
30	.....do	......do	159 31
30	Isaac B. Dunn	......do	103 80
30	F. A. Wordell	......do	89 30
30	Elmer H. Craig	......do	106 29
30	H. R. McCalmont	......do	138 50
30	James H. Clements	......do	196 70
30	O. N. Miller	......do	138 30
30	D. I. Murphy	......do	80 20
30	L. A. Brandebury	......do	110 41
30	Franklin Wood	......do	147 17
30	Great Falls Ice Company	Ice	123 17
30	G. H. Ragsdale	Special service	129 00
30	A. S. Coleman	......do	141 86
30	John H. Wager	......do	78 90
30	Washington Gas-Light Company	Gas	44 55
30	E. J. Hayward	Washing towels	14 44
July 9	William Hutchinson	Special service*	168 55
9	M. E. Jenks	......do	74 80
9	Joseph Carr	......do	132 90
9	F. H. Sprague	......do	105 16
9	Jos. Loughran	......do	115 10
9	C. R. Conner	......do	132 67
9	P. H. Berkan	......do	112 35
10	J. W. Morris	......do	134 47
11	John Edw. Mason	......do	136 95
14	A. W. Fisher	......do	32 50
19	W. R. Bates	......do	135 07
23	J. A. Macauley	......do	163 41
24	A. T. Morgan	......do	73 37
27	John Moran	Sundries *	49 25
28	Arthur Shepherd	Special service*	200 05
Sept. 18	Western Union Telegraph Co.	Telegraphing*	43 52
Dec. 7	B. R. Shopp	Special service*	2 00
	Amount expended		57,796 90
	Balance on hand unexpended		9,703 10
	Amount appropriated		67,500 00

* These accounts were contracted during the fiscal year ending June 30, 1877.

Statement of expenditures on account of the contingent fund of the Education Office for the fiscal year ending June 30, 1877.

Date.	From whom purchased.	Nature of purchases, &c.	Amount.
1876.			
July 27	F. G. Davis	Repairing cane-seat chairs	$9 80
Aug. 3	E. J. Hayward	Washing towels	1 83
7	E. Q. Gunson	Books	6 00
9	Charles Warren	Car tickets and express charges	21 65
10	E. W. Whittaker	Stationery and books	3 50
10	Western Union Telegraph Co	Telegraphing	3 04
10	F. Leypoldt	Trade List Annual	1 00
11	William T. Harris	Journal of Speculative Philosophy	21 00
11	Hurd & Houghton	Public Health Report	9 50
23	F. S. Gaither	Corrosive sublimate, alcohol, &c	3 00
23	Adams Express Company	Expressage	13 75
23	C. H. Emmerson & Co	One year's subscription to Business Guide of Washington.	5 00
24	A. N. Bell	Subscription to Sanitarian	2 25
26	A. K. Williams	Report Bureau of Education, 1867-'68	3 50
26	Lorenzo Rice	Cleaning carpets	6 35
30	William Ballantyne	Stationery	25 24
30	......do	......do	52 20
31	Arthur Simmons	Services as messenger for August	10 00
Sept. 1	A. K. Williams	Report Vienna Exposition	4 00
2	J. G. Weaver	Mounting maps on rollers, and lumber and labor making box.	11 00
5	E. J. Hayward	Washing towels	1 98
9	Western Union Telegraph Co	Telegraphing	4 55
14	Lorenzo Rice	Cleaning carpets	5 95
15	Solomons & Chapman	Stationery	20 00
22	J. S. Kellogg	Reports Bureau of Education	24 00
22	S. R. Warren	Car tickets and express charges	30 03
25	Mancel Philp	Services for seven days, at $1.50	10 50
27	Atlantic and Pacific Telegraph Co.	Telegraphing	3 85
30	J. G. Weaver	Upholstering—mounting maps on rollers	20 00
30	Bangs, Merwin & Co	Lot of early American school-books	10 77
July 31	Pay roll	Collecting statistics	913 40
Aug. 31	......do	......do	652 49
Sept. 30	......do	......do	746 60
Oct. 5	Johnson Brothers	Coal	274 00
5	Great Falls Ice Company	Ice	24 18
5	E. J. Haywood	Washing towels	1 83
19	A. B. Shaw	Push-cart	12 00
21	S. R. Warren	Car tickets and express charges	16 00
21	C. A. Spofford	Traveling expenses to New York and return	22 79
23	James St. John Stationery Co	Stationery	172 80
28	A. Simmons, jr	Services as messenger	2 66
28	H. M. Rogers	Services as copy-holder	14 00
Nov. 1	Adams Express Company	Expressing	5 85
1	Charles Warren	Car tickets and express charges	10 25
3	E. M. Whittaker & Son	Books	33 50
4	A. Schumacher & Co	Freight	3 63
11	E. M. Whittaker & Son	Stationery	198 72
13	Adams Express Company	Expressing	4 00
13	L. W. Schmidt	German books	28 90
15	E. J. Hayward	Washing towels	1 26
16	J. H. Johnson	Books	1 65
16	Atlantic and Pacific Telegraph Co.	Telegraphing	4 54
16	Franklin Telegraph Company	......do	85
16	J. H. Johnson	Arithmetic (1)	50
21	Western Union Telegraph Co	Telegraphing	2 00
21	......do	......do	50
21	Mohun Brothers	Stationery	204 64
21	Adams Express Company	Expressage	4 75
21	......do	......do	29 25
23	Charles Warren	Car tickets and express charges	13 80
24	F. Leypoldt	Subscription to American Library Journal	5 00
25	D. McIntosh	Services as proof-reader	65 33
27	Adams Express Company	Expressage	18 25
27	Mrs. S. S. Gaither	Oil silk (for wrapping books for long sea-voyage).	1 75
28	Adams Express Company	Expressage	8 00
29	Peter Moseley	Washers for strengthening cart belonging to bureau.	50
Dec. 1	J. G. Weaver	Packing-boxes	53 00
1	J. O. Parker	Stationery	5 70
2	Walter Allen, jr	Knight's Mechanical Dictionary	3 00
5	James Anglim	Books	5 80
7	Mohun Brothers	Stationery	132 60
8	E. J. Hayward	Washing towels	1 29
11	J. Bradley Adams	Stationery	168 71
15	A. Schumacher & Co	Expressage	40
[illegible]	J. E. Doxey	Express charges advanced	35

Statement of expenditures on account of the contingent fund, &c.—Continued.

Date.	From whom purchased.	Nature of purchases, &c.	Amount.
1876.			
Dec. 15	Hoff & Thomas	Diploma cases	$36 00
20	E. C. Fairchild	Third volume Johnson's Encyclopedia	12 75
26	Western Union Telegraph Co.	Telegraphing	37
26	J. Ormond Wilson	Books	7 00
27	A. Schumacher & Co.	Express charges and ocean freight on three boxes.	8 76
27	Atlantic and Pacific Telegraph	Telegraphing	3 44
29	J. H. Johnson	Books	4 25
30	Charles Warren	Street-car tickets and express charges	20 99
30	James Anglim	Books	46 45
30	Great Falls Ice Company	Ice	15 73
30	L. C. Campbell	Hardware	20 62
30	Adams Express Company	Expressage	10 65
Oct. 31	Pay roll	Collecting statistics	701 50
Nov. 30	......do	......do	537 30
Dec. 31	......do	......do	602 60
1877.			
Jan. 8	E. J. Hayward	Washing towels	1 35
8	W. H. Barnes	Books	25 00
8	J. Dennis, jr	Text-books	1 80
9	Young Men's Christian Association	Old newspapers	5 75
12	Boyd's Directory Company	Directory	5 00
13	A. K. Williams	Set of United States Reports on Vienna Exhibition.	3 50
15	George S. Moulton	Magazines	1 40
15	W. S. Tappan	Repairing clock	2 50
17	A. T. Barnes & Co.	Subscription to International Review	5 00
20	J. W. Gregory	Hardware	75 00
23	Atlantic and Pacific Telegraph Co.	Telegraphing	1 00
23	W. S. Mitchell	Carpet-lining	12 50
30	Charles Warren	Street-car tickets, &c.	11 85
30	A. T. Barnes & Co	Magazine subscription	5 00
30	E. W. Nash	Books	13 25
31	Young Men's Christian Association	Old newspapers	2 15
Feb. 2	Charles Fischer	Reading-glass (for use in deciphering manuscript).	3 50
3	Baltimore and Ohio Railroad	Freight	11 70
3	Solomons & Chapman	Books	32 40
3	E. J. Hayward	Washing towels	1 65
3	E. M. Whittaker	Magazine subscription	15 00
3	National Republican	Subscription Daily Republican	8 00
5	F. W. Christian	Books	10 00
5	William Ballantyne	Stationery	15 00
5	......do	Books	68 41
7	J. Disturnell	......do	3 00
8	Adams Express Company	Expressage	32 55
13	J. H. Johnson	Books	6 10
15	B. Westerman & Co	......do	15 65
17	McMenamy & Co	Periodicals	4 80
17	E. M. Whittaker & Co	Books	18 50
19	Mancel Philp	Services compiling statistics	15 00
19	A. E. La Merle	......do	77 50
19	F. Chatterton	......do	15 00
23	A. Brown	Repairing push-cart	2 00
24	J. Ormond Wilson	Books	12 50
24	W. H. Harrover	Matches and hardware	7 64
28	Young Men's Christian Association	Old newspapers	1 65
Mar. 6	N. R. Stedman & Co	Gray's Atlas	16 00
7	E. J. Hayward	Washing towels	1 38
7	William Ballantyne	Stationery	78 05
8	Adams Express Company	Expressage	13 80
17	Republic Newspaper Company	Republic Magazine	12 00
20	J. H. Johnson	Books	2 75
20	Ker, Clark & Trunnell	Towels	6 00
26	E. C. Wines	Books	7 00
26	J. H. Johnson	......do	4 65
30	E. Steiger	......do	12 00
31	Young Men's Christian Association	Old newspapers	1 65
31	Great Falls Ice Company	Ice	7 47
Jan. 31	Pay-roll	Collecting statistics	599 90
Feb. 28	......do	......do	583 20
Mar. 31	......do	......do	[illegible]
31	E. W. Woodruff	File-holders	10 00
Apr. 6	Adams Express Company	Expressage	7 15
7	J. B. Adams	Stationery	112 84
7	Solomons & Chapman	......do	121 01
11	E. O. Gunson & Co	Periodicals	4 20
13	J. H. Johnson	Text-books	7 50
14	J. R. Osgood & Co	Book	10 00
19	Henry Barnard	Books	828 00
19	J. H. Johnson	Text-books	2 00

Statement of expenditures on account of the contingent fund, &c.—Continued.

Date.	From whom purchased.	Nature of purchases, &c.	Amount.
1877.			
Apr. 28	J. H. Johnson	Text-books	$5 20
May 2	E. J. Hayward	Washing towels	3 94
3	Young Men's Christian Association	Old newspapers	1 50
3	William Ballantyne	Stationery	2 40
3	......do	Books	16 99
4	F. Leypoldt	Periodicals	3 20
4	A. Schumacher & Co	Freight	1 25
5	Adams Express Company	Expressage	6 25
8	Charles Warren	Car tickets and express charges	12 95
11	J. H. Johnson	Text-books	2 59
12	B. F. Stevens	Books, pamphlets, &c	529 59
22	Metropolitan Railway Company	Car tickets	10 00
29	John Eaton, jr	Cash expended while attending meeting at Harrisburg.	14 35
June 4	E. J. Hayward	Washing towels	1 68
5	E. C. Fairchild	Volume 4, Johnson's Encyclopedia	12 75
11	Webb & Beveridge	Water-set and match-safe	17 25
13	Adams Express Company	Express charges	3 05
15	Edward Renaud	Service unpacking and arranging library	39 00
15	C. H. Wye	......do	12 75
15	Rooks Turner	Service assorting and arranging documents.	25 00
15	Charles Erickson	......do	25 00
Apr. 30	Pay-roll	Collecting statistics	566 00
May 31	......do	......do	568 00
June 18	A. Schumacher & Co	Ocean freight	1 25
20	E. W. Woodruff	File-holders	20 00
21	Charles Erickson	Unpacking and arranging library	9 00
22	Mancel Philip	......do	9 00
23	A. N. Bell	Subscription to Sanitarian	3 00
23	Edward Renaud	Unpacking and arranging library	21 00
25	J. B. Philp	......do	60 00
25	Young Men's Christian Association	Old newspapers	2 70
28	Columbia Street-Railway Company	Car tickets	2 00
30	L. C. Campbell	Hardware	5 04
30	Edward Renaud	Unpacking and arranging library	18 00
30	J. B. Philp	......do	18 00
30	William Gronert	......do	78 00
30	R. J. Clarke	Window-shades	66 43
30	A. R. Shepherd & Co	Wash-stands, chandeliers, shades, &c	175 47
30	John McKenny	Service in removing bureau	6 00
30	Great Falls Ice Company	Ice	10 30
30	Adams Express Company	Expressage	8 90
30	Pay-roll	Collecting statistics	525 40
30	E. J. Hayward	Washing towels	1 12
30	Western Union Telegraph Co	Telegraphing	2 98
30	Charles Warren	Car tickets and hauling	7 70
30	Adams Express Company	Expressage	1 45
30	J. W. Boteler & Bro	Dusters, drop-light, and water-set	20 85
30	W. B. Moses	Window-shades and desk	49 25
30	John Eaton	Expenses incurred in visiting institutions of learning.	37 65
	Amount expended		12, 898 96
	Balance on hand unexpended		1 04
	Amount appropriated		12, 900 00

Statement of expenditures on account of the contingent fund of the Indian Office for the fiscal year ending June 30, 1877.

Date.	From whom purchased.	Nature of purchases, &c.	Amount.
1876.			
Aug. 3	E. J. Hayward	Washing towels	$2 10
21	Henry Compton	Cartage	75
[illegible]	[illegible]xpress Company	Expressage	1 40
21	......do	......do	80
24	......do	......do	30
24	Parker & Co	Ink	90
25	John R. Grisburne	Ruling-pens	3 00
25	T. P. Connelly	Notarial services	50
28	E. H. King	Cabinet-work, &c	350 00
Sept. 1	Adams Express Company	Expressage	10 00
2	James Hudson	Painting, &c	200 00
5	Adams Express Company	Expressage	40

Statement of expenditures on account of the contingent fund, &c.—Continued.

Date.	From whom purchased.	Nature of purchases, &c.	Amount.
1876.			
Sept. 5	E. J. Hayward	Washing towels	$2 76
5	Adams Express Company	Expressage	3 00
9	Henry K. Cruit	Plumbing, &c	14 00
14	George Ryneal, jr	Gilt molding	1 62
14	W. H. Barnard	Electric pen, &c	35 00
14	M. E. Fry	Envelope-rack	15 00
15	Adams Express Company	Expressage	25
16	W. F. Beasley	Desk-lock	24 00
16	J. E. Parker	Stationery	1 50
19	M. E. Fry	Making case for electric-pen apparatus	7 00
20	Adams Express Company	Expressage	5 70
21	James St. John Stationery Co	Stationery	648 00
23	R. B. Ferguson	Chemicals	4 85
23	J. Brad. Adams	Letter-press and stand	22 00
28	G. Chelini	Repairing furniture	40 00
29	George Ryneal, jr	Brush	25
30	Adams Express Company	Expressage	1 85
30	John Malvin	Cartage	50
30	Adams Express Company	Expressage	3 80
30	Great Falls Ice Company	Ice	43 68
30	James St. John Stationery Co	Ink	74 17
Oct. 5	G. Hartig	Set of casters	40
5	E. J. Hayward	Washing towels	1 98
9	Adams Express Company	Expressage	30
13	George Francis	Corkscrew	20
13	G. Chelini	Repairing furniture, &c	43 00
13	E. A. McGraw	Candles	80
14	George C. Maynard	Putting in electric apparatus, annunciator, &c.	301 50
14	J. L. Brown	Repairing cases, hanging doors, graining, &c	80 00
19	Henry Jackson	Repairing chair	1 40
21	W. F. Lutz	Dating-stamp	16 00
23	Mohun Brothers	Stationery	508 70
23	Henry Compton	Cartage	75
24	Adams Express Company	Expressage	75
24	......do	......do	90
26	......do	......do	1 25
28	J. C. Parker	Stationery	4 00
28	Adams Express Company	Expressage	3 30
28	......do	......do	75
Nov. 2	H. K. Cruit	Plumbing, &c	10 51
3	G. Chelini	Repairing furniture	7 00
3	Baltimore and Potomac Railroad Co	Transportation	1 67
3	W. D. Wyvill	Grate, &c	36 50
4	Adams Express Company	Expressage	75
6	W. Brown	Cotton cloth	11 44
6	Metropolitan Railroad Company	Car tickets	10 00
10	Adams Express Company	Expressage	1 00
15	E. J. Hayward	Washing towels	2 04
15	W. S. Tappan	Repairing water-pitcher	50
15	George Ryneal, jr	Paste-brush	1 40
16	George Wooldridge	Soap and camphor	68 40
16	Hall & Hume	......do	14 28
16	George Francis	Tacks	90
21	Adams Express Company	Expressage	1 25
23	E. M. Whittaker	Stationery	269 20
25	J. G. Weaver	Repairing furniture	18 00
25	W. W. Brown	Cotton cloth	9 88
27	J. L. Brown	Map-sticks	82 50
29	H. A. Jackson	Repairing furniture	9 30
29	E. A. McGraw	Matches	3 50
Dec. 4	Cincinnati Commercial	Subscription	14 00
5	L. Rice	Cleaning carpet	3 75
6	W. S. Mitchell	Matting, carpet, &c	725 88
6	Mohun Brothers	Stationery	1 75
7	H. O. Towles	Desks	224 00
8	E. J. Hayward	Washing towels	2 79
8	George C. Maynard	Repairing electrical apparatus, &c	22 00
8	Adams Express Company	Expressage	80
8	Henry Compton	Cartage	50
11	W. F. Lutz	Repairing stamp	1 00
14	W. W. Brown	Cotton cloth	45 00
30	F. P. May & Co	Spring punches	36 00
30	George Francis	Tacks	2 00
30	W. H. Boyd	City Directories	10 00
30	James Cooper	Paste	9 00
30	George Francis	Coal-shovels	1 20
30	Great Falls Ice Company	Ice	31 92
30	W. Smith	Cartage	75
30	George Francis	Rat-traps	1 50
30	Metropolitan Railroad Company	Car tickets	5 00

Statement of expenditures on account of the contingent fund, &c.—Continued.

Date.	From whom purchased.	Nature of purchases, &c.	Amount.
1877.			
Jan. 8	Adams Express Company	Expressage	$2 75
8	E. J. Hayward	Washing towels	2 31
9	George Ryneal, jr	Gilt molding, lamps, oil, &c	7 97
10	John Markriter	Window-shades, &c	40 00
10	L. H. Schneider	Locks, thermometer, &c	4 05
16	Henry Compton	Cartage	50
24	S. Carroll	do	1 50
31	H. Compton	do	50
Feb. 3	National Republican	Subscription	8 00
3	E. J. Hayward	Washing towels	3 30
3	J. B. Adams	Stationery	5 00
5	E. Morrison	Shipping-tags	1 50
7	J. Disturnell	Blue Book (2 copies)	3 00
8	Henry Compton	Cartage	50
9	Metropolitan Railroad Company	Car tickets	10 00
14	J. G. Weaver	Repairing desks, &c	9 50
14	E. C. Skidmore	Book-racks	36 00
17	E. W. Woodruff	File-holders	70 00
20	W. B. Williams	Chair	16 00
20	Henry Compton	Cartage	50
Mar. 7	E. J. Hayward	Washing towels	2 49
8	J. B. Adams	Stationery	7 60
9	E. Morrison	Shipping-tags	15 00
15	Mohun Brothers	Stationery	1 65
16	H. A. Jackson	Repairing office-chairs	4 50
17	M. Badger	Cartage	50
23	Metropolitan Railroad Company	Car tickets	10 00
24	Henry Compton	Cartage	50
24	J. B. Adams	Stationery	6 20
27	T. C. Connolly	Notarial services	19 75
27	D. Kolb	Alcohol	25
28	Henry Compton	Cartage	50
31	Great Falls Ice Company	Ice	32 34
31	G. C. Maynard	Connecting electric bell-wires	1 50
Apr. 7	W. F. Lutz	Dating-stamp and repairs	6 00
9	H. Compton	Cartage	50
10	J. W. Freadman	Cotton cloth	25 00
15	D. Kolb	Hair-brush	1 50
17	George Savage	Twine	1 50
20	J. T. Bristow	Rubber stamp	1 00
21	J. B. Adams	Stationery	1 00
May 2	E. J. Hayward	Washing towels	4 89
2	D. Kolb	Glycerine	35
4	F. P. May & Co	Spring punches	12 00
5	Adams Express Company	Expressage	2 45
9	J. B. Adams	Stationery	1 62
10	L. H. Schneider	Rat-trap	1 25
10	Schmedtie Brothers	Clock	10 00
11	W. B. Williams	Furniture	25 00
12	Webb & Beveridge	Basin and ewer	1 25
14	H. A. Jackson	Repairing furniture	3 25
15	T. E. McGraw	Matches	3 50
16	Daily Nation	Subscription	1 04
17	J. G. Weaver	Packing-box and map-sticks	23 00
18	Henry Compton	Cartage	50
24	W. W. Burdette & Co	Towels	13 50
25	E. C. Scidmore	Book-rack	20 00
26	S. E. Smith	Putting loops on towels	1 00
28	D. Kolb	Glue	25
29	George Francis	Water-coolers, &c	16 00
31	John Markriter	Wall-paper	2 60
June 1	D. Kolb	Indelible ink	25
2	George C. Maynard	Renewing batteries, &c	11 25
2	J. L. Brown	Repairing file-cases	15 00
4	J. G. Weaver	File-boards, repairing furniture, &c	68 37
4	E. J. Hayward	Washing towels	3 10
5	George Breitbarth	Office furniture	97 50
5	Willett & Libby	Lumber	2 33
6	L. H. Schneider	Hardware	2 45
6	E. Morrison	Shipping-tags	37 50
7	D. Kolb	Glue	1 50
7	Adams Express Company	Expressage	8 40
13	W. H. Barnard	Supplies for electrical pen	2 80
16	J. G. Weaver	Book-case and step-ladder	50 00
20	H. O. Towles	Office-furniture	83 00
21	George Ryneal, jr	Lamps	11 00
23	George Breitbarth	Office-furniture	49 50
26	Webb & Beveridge	Umbrella-stand	3 00
30	James Cooper	Paste	12 00
30	Metropolitan Railroad Company	Car tickets	10 00

Statement of expenditures on account of the contingent fund, &c.—Continued.

Date.	From whom purchased.	Nature of purchases, &c.	Amount.
1877.			
June 30	Great Falls Ice Company	Ice	$32 34
30	Adams Express Company	Expressage	30
30	E. J. Hayward	Washing towels	2 65
27	George C. Maynard	Renewing batteries and repairing wires	4 50
29	W. S. Mitchell	Matting, carpets, &c	149 34
30	Webb & Beveridge	Umbrella-stand	3 00
July 13	L. H. Schneider	Hardware	2 93
Aug. 6	W. H. Dunn	Furniture	8 00
Oct. 25	Morgan Envelope Company	Stationery	68 60
July 10	T. E. McGraw	Candles	1 60
	Amount expended		5,637 04
	Balance on hand unexpended		362 96
	Amount appropriated		6,000 00

45TH CONGRESS, 2d Session. } HOUSE OF REPRESENTATIVES. { Ex. Doc. No. 43.

NEW BARRACKS AT FORT MONROE, VA.

LETTER

FROM

THE SECRETARY OF WAR,

RECOMMENDING

Appropriation for six new buildings at Fort Monroe, Va.

FEBRUARY 5, 1878.—Referred to the Committee on Appropriations and ordered to be printed.

WAR DEPARTMENT,
Washington City, February 4, 1878.

The Secretary of War has the honor to call the attention of the House of Representatives to the papers and plans concerning the erection of new barracks at Fort Monroe, Va., transmitted on the 20th December, 1875, published in House Ex. Doc. No. 30, Forty-fourth Congress, first session, and to renew the recommendation made at that time by his predecessor, that an appropriation of $100,000 be made by Congress for the six buildings required.

Copies of papers and plans of the buildings are herewith submitted.

GEO. W. McCRARY,
Secretary of War.

The SPEAKER *of the House of Representatives.*

COPIES OF PAPERS RELATING TO, AND PLANS AND ESTIMATES FOR, THE ERECTION OF NEW BARRACKS AT FORT MONROE, VA.

HEADQUARTERS ARTILLERY SCHOOL, U. S. A.,
Fort Monroe, Va., March 1, 1875.

SIR: I have the honor to transmit herewith the report of the senior medical officer of this post (Surgeon Joseph R. Smith, U. S. A.), dated the 27th ultimo, on the condition of the barracks, kitchen, and laundresses' quarters occupied by this command. I am certain that I cannot endorse Surgeon Smith's statements and views too strongly.

Although I have reported annually for the past six years the faulty construction, limited capacity, and decayed condition of these buildings, and have urgently asked for the erection of new buildings, I nevertheless here repeat some of the details.

These barracks and kitchens were built in 1862–'63, of unseasoned lumber, felled and sawed in the vicinity, by the labor of the enlisted men, on extra duty, at a cost for the fourteen buildings, as I am informed, of less than one thousand dollars. Built hastily during the early years of the war, they were intended to subserve only a temporary purpose. They soon began to fall into decay, and for the past five or six years have only been kept from falling upon the heads of the occupants by assiduous patching, supporting, underpinning, &c. They are leaky, insufferably hot in summer, and cold in winter, and are now become altogether too much decayed to admit of repair.

Three years ago the Board of Engineers for Fortifications, made aware of the condition of these buildings by my frequent reports, digested and reported plans and specifications for new and permanent fire-proof structures. These plans, as I have been informed, received the approval of the Chief of Engineers and the Secretary of War, and would seem only to await the asking of the necessary appropriation by Congress.

Last year Major Sawtelle, quartermaster United States Army, made a critical examination of the old buildings, and prepared plans for others to replace them. These last are not understood to be of the permanent character that the location demands.

Still, if the engineer plan is not to be put in execution at once, the plan of the Quartermaster's Department should be.

The comfort, decency, and health of the garrison imperatively demand new buildings as soon as it is practicable to erect them.

I beg most earnestly to invite the attention of the proper authorities to this subject.

Very respectfully, your obedient servant,

WILLIAM F. BARRY,
Colonel Second Artillery, Bvt. Major-General, Commanding.

The ASSISTANT ADJUTANT-GENERAL,
Headquarters Military Division of the Atlantic, New York City.

FORT MONROE, VA., *February* 27, 1875.

SIR: I have the honor to report that I have made the examinations required by General Order 125, A. G. O., 1874.

The general sanitary condition of the post is good, and requires no comment or recommendation.

I deem it my duty, however, to ask the special attention of the commanding officer to those buildings occupied by the companies as quarters. These are seven in number, wooden structures, with buildings of the same general character in the rear, serving as kitchen, mess, and wash rooms.

These buildings are too small to answer the purposes for which used, and were so reported by my predecessor, Surgeon Cooper, in 1870. Were this the only fault of these buildings, I might not deem it so imperative upon me to attempt to disturb the status which has existed for several years. But while, since 1870, this one fault has remained unchanged, in other respects the condition of these buildings has greatly deteriorated.

Constructed of wood, on the outer side of the frame-work are nailed wide upright boards, the seams battened with narrow strips. Inside the frame are nailed narrow boards, tongued and grooved. The roofs are shingled and ceiled, like the inner wall, with narrow tongued and grooved boards, following generally the slope and contour of the roof. In the ceiling of each barrack are two louvered ventilating openings. The floor is also tongued and grooved, and outside the buildings, from the floor to the ground, horizontal boards are nailed.

The roofs of all these quarters leak even when new-shingled within a year. The green material entering into the construction of the walls, floors, and ceilings, has now rotted and shrunk, so that many cracks exist, and the buildings are so open as to have made it impossible to keep them comfortably warm during the present winter.

In consequence of this shrinkage, decay, and loss of strength, their outlines are deflected

from straight lines; they are sunken; they totter with every moderate wind, and they are in danger of falling, in case of a violent gust, and imperiling the safety of their occupants.

I therefore regard them as entirely unfit to be occupied by the troops, and I earnestly recommend that they may be removed and replaced.

I have not deemed it necessary to send, in company with this report, plan and specifications for suitable barracks, as I am informed that heretofore they have been made and forwarded.

Under these circumstances, I request the endorsement, by the commanding officer, of my statements and recommeudations, and ask that he will submit this report to the proper authority, with such remarks as he may deem germane to the subject.

Very respectfully, your obedient servant,

JOS. R. SMITH,
Surgeon, U. S. A.

Lieut. C. O. HOWARD,
Post Adjutant, Fortress Monroe.

[First indorsement.]

HEADQUARTERS DIVISION OF THE ATLANTIC,
New York, March 3, 1875.

Respectfully referred to the medical director of the division for report and recommendations.

By command of Major-General Hancock:

JAMES B. FRY,
Assistant Adjutant General.

[Second indorsement.]

MEDICAL DIVISION OFFICE, DIVISION OF THE ATLANTIC,
New York, March 11, 1875.

Respectfully returned to headquarters Division of the Atlantic, concurring in the recommendation and views of the post surgeon and commanding officer for the erection of suitable buildings at this post, the necessity for which is very urgent.

JNO. M. CUYLER,
Surgeon U. S. A., Medical Director Division of the Atlantic.

[Third indorsement.]

HEADQUARTERS DIVISION OF THE ATLANTIC,
New York City, March 12, 1875.

Respectfully referred to the chief quartermaster of the division for report and recommendation.

By command of Major-General Hancock:

JAMES B. FRY,
Assistant Adjutant-General.

[Fourth indorsement.]

HEADQUARTERS MILITARY DIVISION OF THE ATLANTIC,
Office Chief Quartermaster, New York, March 13, 1875.

Respectfully returned to the assistant adjutant-general Military Division of the Atlantic.

I fully concur in the within remarks of Colonel Barry, and earnestly recommend that early action be taken toward having suitable quarters provided.

The matter has been considered by the Quartermaster-General, with whom I have conferred on the subject. The plan proposed by him I regard as a very good one, and cannot too strongly urge its adoption and the erection of the building at as early a day as possible.

RUFUS INGALLS,
Col. and A. Q. M. Genl., Bvt. Maj-Genl. U. S. A., Chief Quartermaster.

[Fifth indorsement.]

HEADQUARTERS DIVISION OF THE ATLANTIC,
New York City, March 15, 1875.

Respectfully forwarded to the assistant adjutant-general, headquarters of the Army, inviting attention to the foregoing indorsement hereon, by the chief quartermaster of the division.

WINF'D S. HANCOCK,
Major-General, Commanding.

[Sixth indorsement.]

HEADQUARTERS OF THE ARMY,
Saint Louis, March 20, 1875.

Respectfully forwarded to the Adjutant-General.
By command of General Sherman:

WM. D. WHIPPLE,
Assistant Adjutant-General.

[Seventh indorsement.]

WAR DEPARTMENT, ADJUTANT-GENERAL'S OFFICE,
Washington, March 24, 1875.

Respectfully referred to the Quartermaster-General.

E. D. TOWNSEND,
Adjutant-General.

[Eighth indorsement.]

Respectfully returned to the Adjutant-General United States Army.

The barracks plan, of which a copy is with these papers, is certain to make an unwholesome building, and the estimated cost is $176,000.

The Quartermaster's Department cannot legally undertake such an expense, and if the Engineer Department has plans for permanent barracks, as part of the fortress, it will not be advisable for this department to lay other plans before Congress. I cannot advise the expenditure of twenty-three to twenty-eight thousand dollars in building quarters for laundresses at Fort Monroe. Erection of so costly a building, and a permanent one, is prohibited by law. (Section 1136, Revised Statutes.)

The Secretary has authorized construction of one block of buildings in *pisé* to accommodate four officers; the plans have been modified accordingly.

I inclose plans (herewith, marked B,) for accommodations for the same number of companies on the published plan which occupies about the same space on the parade as the plan from headquarters Division of the Atlantic (herewith marked C).

This would be less costly and much more healthy and comfortable; but still its cost is beyond the means at present available.

So much is wanted at Fort Monroe that I doubt whether full relief can be given until, on a well-devised plan, Congress can be prevailed upon to make a special appropriation, and if the Engineer Department is considering the subject of providing permanent quarters for its garrison, this department should not interfere, or both will fail.

The whole amount of the estimate for quarters and barracks in Division of the Atlantic, according to the plans prepared at division headquarters under instructions to that effect from the Secretary of War of August 8, 1874, is $1,496,562.

The plans are in many cases such as I could not advise the Secretary to lay before Congress, and the total is so great that there was no prospect of success at the late session.

I attempted to simplify and economize in the cost of the officers' quarters, but as the Secretary decided that these less costly plans were still too costly, I have prepared, and this day submitted (in the Fort Whipple case), plans for quarters for officers of a company, in exact accordance with his views as recently communicated.

The drawings for the buildings already authorized at Fort Monroe will be ready in a few days.

M. C. MEIGS,
Quartermaster-General, Brevet Major-General, U. S. A.

[Ninth indorsement.]

WAR DEPARTMENT, ADJUTANT-GENERAL'S OFFICE,
Washington, April 12, 1875.

Respectfully submitted to the Secretary of War.

E. D. TOWNSEND,
Adjutant-General.

MEMORANDUM.

WAR DEPARTMENT, INSPECTOR-GENERAL'S OFFICE,
Washington, April 20, 1875.

As Fort Monroe is one of the most important points in our system of sea-coast defenses, which will doubtless continue to be occupied for many years, besides possessing interest as the location of the artillery school, it will probably, in the future, as it has been in the past, frequently be visited by foreign dignitaries. In view of which it seems no more than reasonable that its garrison should be quartered in permanent, sightly barracks, built upon correct sanitary principles.

I would therefore very respectfully recommend that the Engineer Department be directed to prepare and submit to the Secretary of War suitable plans for such buildings, to be presented to the next Congress for a special appropriation.

R. B. MARCY,
Inspector-General.

WAR DEPARTMENT, *April* 24, 1875.

Respectfully returned to the Adjutant-General.

The views of General Marcy are concurred in, and recommendation will be made to Congress at its next session for building the necessary buildings, an estimate of which should be sent before August 31st next, so that it may be included in the annual estimates.

By order of the Secretary of War:

H. T. CROSBY,
Chief Clerk.

[Tenth indorsement.]

WAR DEPARTMENT, ADJUTANT-GENERAL'S OFFICE,
Washington, April 29, 1875.

Respectfully referred to the Chief of Engineers, to cause the necessary plans and estimates to be prepared and submitted in accordance with the instructions of the Secretary of War, indorsed on the accompanying memorandum from the Inspector-General.

E. D. TOWNSEND,
Adjutant-General.

[Eleventh indorsement.]

OFFICE OF THE CHIEF OF ENGINEERS,
Washington, May 4, 1875.

Respectfully referred to the Board of Engineers for Fortifications for report.

If the plans and estimates of the board of April 3, 1872, do not, in its judgment, need revision, the board can submit them in answer to this communication.

By command of Brigadier-General Humphreys:

THOS. LINCOLN CASEY,
Lieutenant-Colonel of Engineers.

[Twelfth indorsement.]

OFFICE BOARD OF ENGINEERS FOR FORTIFICATONS,
New York, July 23, 1875.

Respectfully returned to the Chief of Engineers with report of this date.

J. G. BARNARD,
Colonel of Engineers, and Brevet Major-General,
President Board of Engineers for Fortifications.

OFFICE BOARD OF ENGINEERS FOR FORTIFICATIONS,
Army Building, New York, July 23, 1875.

GENERAL: In pursuance of your instructions of the 4th of May, indorsed upon the communication of Col. William F. Barry, of the 1st of March last, to the adjutant-general Military Division of the Atlantic, the Board of Engineers for Fortifications, having carefully considered the subject of barracks for Fort Monroe, Va., have the honor to submit the following report thereon.

Much study was devoted to the design for barracks at that place, which was submitted to you with report of April 2, 1872, and in its arrangement the board had the benefit of the advice and suggestions of Col. W. F. Barry, commanding at Fort Monroe, who approved of the design, as embodying all the requisites for the health and comfort of the soldier. The plan has again been examined, and the board recommends no change therein except in the spacing of the floor-girders, which should be spaced four feet four and a half inches apart, instead of eight feet nine inches, as shown in the drawing.

The design is open to the objection of being costly, the estimate being $250,000, but it is not possible to make a single building, with any pretension to architectural effect, or fireproof, and affording the same amount of accommodations, which shall cost much less than this sum. It should be observed, moreover, that the dormitories will furnish accommodations for a full company of 100 enlisted men, who will have both the cubical and floor space deemed absolutely essential for health by the Medical Department. Of course, with the present reduced numbers in a company, the men will have about double that amount of space.

The design provides for a thoroughly permanent structure, fire-proof throughout, except in its Mansard roof; but if the floors are made of wood, instead of iron, brick, and concrete, the cost of the structure will be reduced to about $210,000.

A modification of the above design has been made, consisting in the substitution of a parapet wall and flat roof for the Mansard roof of that project. In all other respects the two designs are identical. The estimate is only about $12,000 less than for the former, while it loses the accommodations (dormitories for three companies), which the Mansard story affords. As the plans for the projects are the same, an elevation, only, of the modified one is presented. It has the advantage over the former in not rising so high above the parapets of the fort; while, on the other hand, it does not present the architectural effect which the Mansard roof affords.

It is proper to say that in getting up the design of April 2, 1872, the board was influenced by the feeling which seemed to prevail that the structure should be imposing in its architectural character, a feeling similar to that recently expressed by Inspector-General Marcy in his memorandum accompanying the papers referred to us and approved by the Hon. Secretary of War.

Still, the prescription therein, "permanent sightly barracks, built upon correct sanitary principles," allows a wide range of interpretation. If an imposing building regardless of cost be meant, and if by "permanent," fire-proof be meant, this board can offer nothing which so fully meets these conditions as the plan submitted in 1872, though even that plan derives most of its architectural effect from the addition of its Mansard roof, not fire-proof (which, however, may be burnt off without endangering the rest of the structure).

The modification which we now submit, as an alternative to the original (the characteristics of which have already been given), dispenses with this Mansard, and is fire-proof throughout; but, as will have been observed, the cost is but slightly reduced, while the sightliness is greatly impaired.

Since the board submitted its first plan in 1872, a type or model for barracks for troops has been officially adopted; and though not especially designed to be sightly in an architectural sense, nor permanent, if by that term fire-proof be meant, or even to possess that degree of permanence which the word implies when used in connection with our "permanent fortifications," still it is especially designed with a view to "correct sanitary principles," as they are now taught us, and the board rather inclines to the notion that such structures will be far more comfortable for the men, while they may be made sufficiently permanent and sightly.

A building such as the original plan of the board provides for, while it would be very proper, if, like many great barracks in Europe, it were located in or near a great city, may appear to be in high contrast to what must be its surroundings at Fort Monroe; moreover, it towers 47 feet above the crest of the parapets of that great work.

The modified design, now sent, takes off much of the height; still, it is very costly, puts half of the men in a third story, and does not afford dormitories so comfortable as those of the model plan.

Non fire-proof quarters are inadmissible in works so constructed, as are nearly all our sea-coast forts. But Fort Monroe has such immense interior area that this rule does not apply; if it *did*, all the existing officers' quarters, offices, and other interior buildings would have to be rebuilt at an immense cost.

In the light, therefore, of a question addressed to this board, as acting in its special sphere, to provide *permanent* quarters for Fort Monroe, the condition of mere permanence does not seem to compel us to incur the immense cost of making them fire-proof; the more espe-

cially as, for our purpose, several distinct buildings are quite as admissible as a single grand one, for which *dimensions* alone enhance the necessity for fire-proofing.

We therefore submit the plans herewith, with the remark that we are under the impression that, if something on a less expensive scale, and not fire-proof, be considered admissible, buildings according to the design presented by the Board on the Revision of the Army Regulations, and which will afford excellent accommodation when the companies do not exceed sixty men, may be put up at an estimated cost of about $16,000 each, or say not exceeding $100,000 for six buildings.

This design provides a separate two-story building for each company, and is supposed in the estimate above given to have exterior and partition walls of brick, with wooden floors and roof, the latter being covered with slates.

The papers and drawings referred to the board in connection with this subject are herewith returned. The board's plan of 1872 was forwarded to the Engineer Department with reports of board of April 2, 1872.

Respectfully submitted.

J. G. BARNARD,
Colonel of Engineers and Brevet Major-General.
H. G. WRIGHT,
Lieutenant-Colonel of Engineers, Brevet Major-General.

I concur with the board generally, but cannot recommend the plan of barracks with a Mansard roof. Omitting this roof, which rises 47 feet above the parapet of the fort, the building will have three stories, quite height enough, and will give ample accommodation for five companies and the band.

Z. B. TOWER,
Colonel of Engineers, Brevet Major-General.

Brig. Gen. A. A. HUMPHREYS,
Chief of Engineers U. S. A., Washington, D. C.

OFFICE BOARD OF ENGINEERS FOR FORTIFICATIONS,
ARMY BUILDING, CORNER HOUSTON AND GREENE STREETS,
New York City, April 3, 1872.

GENERAL: I have the honor to transmit herewith report of the board upon soldiers' barrack at Fort Monroe, Va., with accompanying drawing.

The papers referred to the board in connection with this subject are herewith returned.

Very respectfully, your most obedient,

J. G. BARNARD,
Col. of Engineers and Bvt. Maj. Genl., President Board Engineers for Fortifications.

Brig. Genl. A. A. HUMPHREYS,
Chief of Engineers U. S. A., Washington D. C.

OFFICE BOARD OF ENGINEERS FOR FORTIFICATIONS,
Army Building, New York, April 2, 1872.

GENERAL: The Board of Engineers for Fortifications have the honor to submit herewith a project for soldiers' barracks proposed to be erected on the parade in rear of the curtain of front 6 of Fort Monroe, Va. The artillery school for practice, now at this fort, requires an accommodation for five companies, each of 60 enlisted men, and a band of say, 20, for which we have amply provided in the three lower stories of the designed building. The fourth or Mansard story supplies half as much more dormitory room for an increased war garrison. The maximum total of bunks for which there is sufficient room is 834, or for the enlisted men of an entire artillery regiment and one additional battery as now established by law.

This barrack of four stories including attic, is 471 feet long and 44 feet broad, except the towers, which project beyond the front and rear, thereby giving additional conveniences and producing good architectural effects. In rear or on the shady side of the building are broad verandas to each of the three lower floors, from which all the entrances are made to the dormitories, mess-rooms, company offices, &c., and for communication to these are four iron stairways in the rear ends of the towers.

The masonry of the structure is designed to be of béton aggloméré, or the walls (made hollow), floor, arches, and stacks may be of brick, which, though increasing the cost, we would prefer in view of our limited knowledge of the power of béton aggloméré to withstand our changeable climate.

An iron roof was first contemplated, to make the barrack entirely fire-proof, but after consultation with experienced builders, such roofs were found to be expensive, always leaking

and requiring constant and troublesome repairs. For these reasons we have adopted rafters and sheathing, with slate for the steep, and tin for the gentle roof slopes. There being no combustible buildings near and this being designed to be warmed by furnaces, the danger of fire is trifling, particularly as the three lower or habitually occupied stories are constructed of iron and masonry, except the doors, windows, and floors (laid directly upon the concrete), which are wood.

In the first story are six mess-halls, six kitchens, six bath-rooms, six company offices with adjoining apartment for orderly sergeants, two spare rooms in end towers, a sally-port through the central towers, two rooms for furnaces and heating apparatus, two commissary stores, and the private stairway for officers and their families visiting the lecture and concert room occupying the whole attic story of the central tower.

As the furnace and commissary rooms adjoin the sally-port, they are accessible to carts conveying coal and provisions.

The second, third, and attic stories are each provided with six dormitories with adjoining lavatories, each having 16 wash-basins; twelve sergeants' rooms; two spare rooms in end towers, and six of various dimensions in the middle tower, designed for clothing rooms, armories, shoemaker and tailor shops, and for such other purposes as are always needed. Each dormitory, intended for half a company, has provision for a maximum of 44 single bunks, or a minimum of 24 if the two middle rows be left out, thus providing 670 to 1,225 cubic feet of air-space per man.

The sleeping accommodation, then, for each of the companies at the school will be—

Dormitories, second and third floors	88 maximum or	48 minimum.
Sergeants' rooms, second and third floors	4 maximum or	4 minimum.
Orderly sergeant on first story	1 maximum or	1 minimum.
Married men lodged out	4 maximum or	4 minimum.
	97	57

This shows liberal accommodation for a company in peace (nominally 60, but rarely 57), and sufficient for a company in war (nominally 100, but rarely 97). Therefore for the artillery school, of five companies and a band, there is ample provision in the three lower stories, leaving the attic unoccupied except for a war garrison

Iron tanks, three feet deep, are placed over all the sergeants' rooms of the third story to receive the rain-water from the room surfaces, and pipes convey it thence to the wash-basins below. As it is not probable the rain-supply will exceed that required for drinking, cooking, and the lavatories, the water required for baths and the heating apparatus must be furnished by wells.

The mode of warming the barrack, whether by steam-coils in each apartment, or by hot air from a coil-room adjoining the furnace, will require a special study should an appropriation be made for erecting the building.

As will be seen from the accompanying drawing, furnace, kitchen, and ventilating flues to the top of the barracks are provided.

No water-closets are within the building, as we deem it far better, to avoid all disagreeable odors from their careless use, to place them outside in some secluded place, where they may be constructed at small cost.

This structure, simple but effective in its architecture, provides both comfort and convenience for enlisted men, and at a reasonable cost; all that is wanted in peace for the artillery school for practice, and in war for a much increased garrison.

Herewith is an estimate of the cost of construction, based upon prices furnished by General Brewerton, while the constructing officer at Fort Monroe.

This estimate, which is liberal, gives total cost, $200,000.

If the walls, floor, arches, and stacks be built of brick, the additional cost will be $50,000, which is based upon the outer walls being two bricks, with a hollow space, in thickness.

In concluding our report we would remark that while, as a general principle, we do not approve of constructing such buildings *within* permanent works, we make this an exception in consideration of the magnitude of Fort Monroe, and the want of suitable space outside where it will not mask its fires, and as being more convenient for the artillery school for practice.

Respectfully submitted.

J. G. BARNARD,
Colonel of Engineers and Brevet Major-General.
GEO. W. CULLUM,
Colonel of Engineers and Brevet Major-General.

I would prefer the building limited to the three fire-proof stories.

Z. B. TOWER,
Lieutenant-Colonel of Engineers and Brevet Major-General, U. S. A.
H. G. WRIGHT,
Lieutenant-Colonel of Engineers and Brevet Major-General.

Brig. Gen. A. A. HUMPHREYS,
Chief of Engineers U. S. A., Washington, D. C.

[Thirteenth indorsement.]

OFFICE OF THE CHIEF OF ENGINEERS,
Washington, August 21, 1875.

Respectfully returned to the Adjutant-General, with report of the Board of Engineers for Fortifications, inclosing project of permanent barracks designed by it in 1872, with estimate of cost (herewith, marked F), and which is again furnished by the board as a design for the quarters needed at that post, which designs and report meet with my approval. (Plans herewith, marked D and E.)

A. A. HUMPHREYS,
Brigadier-General and Chief of Engineers.

[Fourteenth indorsement.]

WAR DEPARTMENT, ADJUTANT-GENERAL'S OFFICE,
Washington, August 23, 1875.

Respectfully returned to the Secretary of War, with report and plans from the Engineer's Department.

E. D. TOWNSEND,
Adjutant-General.

[Fifteenth indorsement.]

WAR DEPARTMENT, *September* 16, 1875.

Respectfully referred to General Marcy, Inspector General, for his consideration. It is supposed that an appropriation will be required to be asked from Congress at its next session for the purpose indicated.

By order of the Secretary of War:

H. T. CROSBY,
Chief Clerk.

[Sixteenth indorsement.]

WAR DEPARTMENT, INSPECTOR-GENERAL'S OFFICE,
September 16, 1875.

Respectfully returned to the Secretary of War, concurring in the suggestions of the board of engineers contained in the latter part of their report of July 23, 1875, namely, that buildings according to the design presented by the Board on the Revision of the Army Regulations will afford excellent accommodations for companies not exceeding sixty (60) men each, and will be much less costly, and, in my judgment, far more convenient and suitable for troops than the large four-story buildings before recommended by the board of engineers, which would tower 47 feet above the crest of the parapets of the work.

Hence I very respectfully recommend that an appropriation of $100,000 be asked for from Congress for the six buildings required, which it is believed will be amply sufficient to carry out the object.

R. B. MARCY,
Inspector-General.

FORT MONROE, VA, *March* 30, 1875.

SIR: I have the honor to report that I have inspected the various buildings at this post occupied as quarters. The privy for the use of the laundresses and their children is in process of construction.

The soldiers' barracks are as reported last month. Two of the buildings occupied as quarters by officers (Captains Loder and Piper) need to be reconstructed.

In fact the quarters occupied by officers at this post are very inferior, and I recommend that quarters be erected in quality and quantity suitable for at least such number of officers as are permanent at this post.

The health of the command is good and the police of the post excellent.

Very respectfully, your obedient servant,

JOS. R. SMITH,
Surgeon United States Army.

[First indorsement.]

HEADQUARTERS FORT MONROE, VA.,
March 31, 1875.

Respectfully forwarded to headquarters Millitary Division of the Atlantic.

The two buildings herein referred to as occupied by Captains Loder, Fourth Artillery, and Piper, Fifth Artillery, are very old, much decayed, unhealthy, and unsafe. They should be torn down and replaced by new buildings of modern architecture and arrangements.

Four-fifths of the junior commissioned officers at this post live in casements which were built fifty years ago, and which are now leaky and generally unsuited for occupation. At least ten sets of new officers' quarters are essential at this post.

WILLIAM F. BARRY,
Colonel Third Artillery, Commanding.

[Second indorsement.]

HEADQUARTERS DIVISION OF THE ATLANTIC,
New York City, April 2, 1875.

Respectfully forwarded to the assistant adjutant-general, headquarters of the Army, in connection with Surgeon Smith's report for the month of February, forwarded by me on the 15th ultimo. On that report the chief quartermaster of the division indorsed as follows:

"Respectfully returned to the assistant adjutant-general Military Division of the Atlantic. I fully concur in the within remarks of Colonel Barry, and earnestly recommend that early action be taken toward having suitable quarters provided. The matter has been considered by the Quartermaster-General, with whom I have conversed on the subject. The plan proposed by him I regard as a very good one, and cannot too strongly urge its adoption, and the erection of the building at as early a day as possible."

WINF'D S. HANCOCK,
Major-General, Commanding.

[Third indorsement.]

HEADQUARTERS OF THE ARMY,
Saint Louis, April 5, 1875.

Respectfully forwarded to the Adjutant-General.
By command of General Sherman:

WILLIAM D. WHIPPLE,
Assistant Adjutant-General.

WAR DEPARTMENT, *December* 20, 1875.

The Secretary of War has the honor to transmit to the House of Representatives copies of papers and plans concerning the erection of new barracks, &c., at Fort Monroe, Va., and to earnestly recommend that an appropriation of $100,000 be made by Congress for the six buildings required.

WM. W. BELKNAP,
Secretary of War.

HEADQUARTERS ARTILLERY SCHOOL, UNITED STATES ARMY,
Fort Monroe, Va., September 12, 1877.

SIR: I have the honor to earnestly request that the attention of the proper authority be drawn to the immediate necessity which exists for the erection of suitable permanent barracks for enlisted men at this station, and that necessary steps may be taken for speedily securing the requisite appropriation therefor.

The barracks now occupied by the troops are cheap wooden structures of a very temporary nature, and were built during the war of the rebellion on plans which were then in common use for all temporary quarters, being cheaper than tents. They are now old, rotten, unhealthy, and entirely unsuitable for the purpose they are made (for lack of better) to serve.

In reference to this subject I have to state that several attempts have been made to secure the desired end in times past, notably in 1872, '73, and '75, and that the matter has been laid before the Military Committee of the House of Representatives in the form of letters from the Hon. Secretary of War, and has received the favorable consideration of that committee. (Vide Cong. Rep. 1875.)

While the necessity of permanent barracks has been thus fully recognized, circumstances have induced a postponement of action in the premises up to this time. I now regard it that the time has arrived for such action.

In connection herewith, I respectfully inclose for consideration a plan for the desired quarters which is found among the post records (appended, marked C), and is believed to be the result of the deliberations of a board of officers heretofore held on the subject, though no record thereof is on file here, Other plans with specifications are already on file in the Quartermaster's Department.

Very respectfully, your obedient servant,

GEO. W. GETTY,
Colonel Third Artillery, Brevet Major-General, U. S. A., Commanding.

To the ASSISTANT ADJUTANT-GENERAL
Military Division of the Atlantic.

[First indorsement.]

HEADQUARTERS DIVISION OF THE ATLANTIC,
New York, September 14, 1877.

Respectfully referred to the chief quartermaster of the division.
By command of Major-General Hancock:

JAMES B. FRY,
Assistant Adjutant-General.

[Second indorsement.]

HEADQUARTERS MILITARY DIVISION OF THE ATLANTIC,
OFFICE CHIEF QUARTERMASTER,
New York, September 17, 1877.

Respectfully returned to the assistant adjutant-general Military Division Atlantic. The matter of the construction of barracks at Fort Monroe was represented in a report made by Major Sawtelle in December, 1874, in compliance with Special Orders 166, Military Division Atlantic, 1874. In this report it is remarked that "the quarters for the enlisted men are only temporary structures, built during the war of the rebellion, and are wholly unfit for the purpose." The plan suggested by Major Sawtelle contemplated one building with a tower, large enough for occupancy by six companies of artillery and the band, provided for bathing facilities for the men, and an ample supply of water (always a troublesome question at this post) to be obtained from the roof-surface of the building, and stored in a large tank in second-story lower room, taken thence by pipes to company kitchen, bath-rooms, &c., and overflow conducted to cisterns. The cost of this building, of brick, was estimated at $176,000. This plan was approved by Colonel Ingalls and forwarded to division headquarters December 14, 1874. A report on the subject of buildings at Fort Monroe was forwarded to division headquarters March 13, 1875, and on May 6, 1875, this office was furnished with a copy of a letter of the Adjutant-General of the Army to the Quartermaster-General stating that the Secretary of War had approved General Marcy's recommendation that the Engineer Department submit suitable plans for a permanent and sightly barracks at Fort Monroe, to be presented to Congress for a special appropriation. Nothing has since been heard of this matter. Major Sawtelle's report and the plans accompanying it are on file at the War Department. Nothing is known here relative to the inclosed plan. The question of new quarters for the enlisted men at Fort Monroe is an important and urgent one, and the necessity for providing them should be pressed on the attention of Congress until authorized.

L. C. EASTON,
Colonel and Assistant Quartermacter-General, Chief Quartermaster.

[Third indorsement]

HEADQUARTERRS DIVISION OF THE ATLANTIC,
New York, September 18, 1877.

Respectfully forwarded to the Adjutant-General of the Army, inviting attention to foregoing indorsements.

WINF'D S. HANCOCK,
Major-General, Commanding.

[Fourth indorsement.]

ADJUTANT-GENERAL'S OFFICE,
Washington, September 21, 1877.

Respectfully submitted to the Secretary of War, with previous papers.

E. D. TOWNSEND,
Adjutant-General.

[Sixth indorsement.]

Respectfully returned to the honorable Secretary of War. I recommend that another application be made to Congress to appropriate $100,000 for construction of barracks at Fortress Monroe, Virginia, in accordance with the printed plans of buildings recommended to the Secretary of War by the Board on Revision of the Army Regulations, published September 14, 1872.

M. C. MEIGS,
Quartermaster-General, Brevet Major-General, United States Army.

Q. M. G. O., *November* 14, 1877.

Printed plan referred to, annexed, marked A.

A.

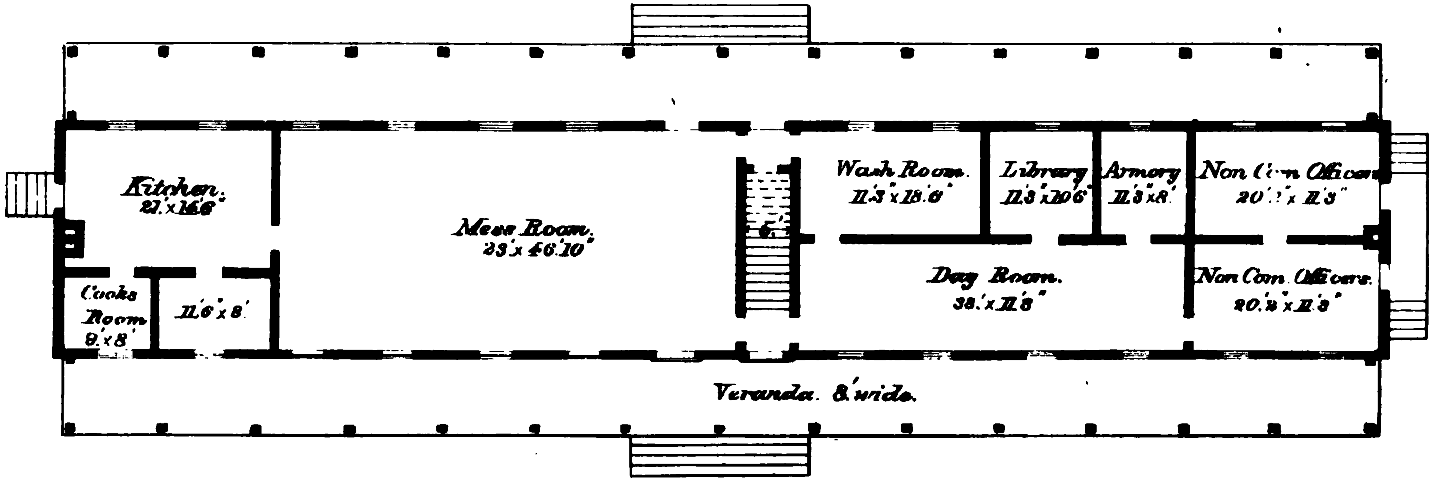
WAR DEPARTMENT,
QUARTERMASTER-GENERAL'S OFFICE,
Washington, D. C., September 14, 1872.

The accompanying drawings of military buildings were recommended to the Secretary of War by the Board on Revision of the Army Regulations.

M. C. MEIGS,
Quartermaster-General, Brevet Major-General, United States Army.

No. 1.

COMPANY QUARTERS.

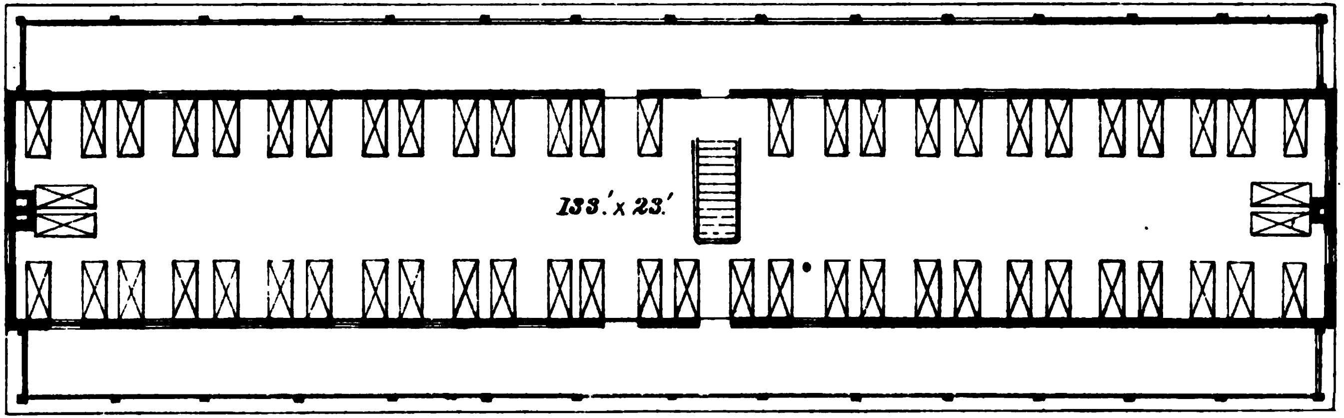


Plan of 1st Story.

Scale 20 feet to 1 inch.

No. 2.

COMPANY QUARTERS.

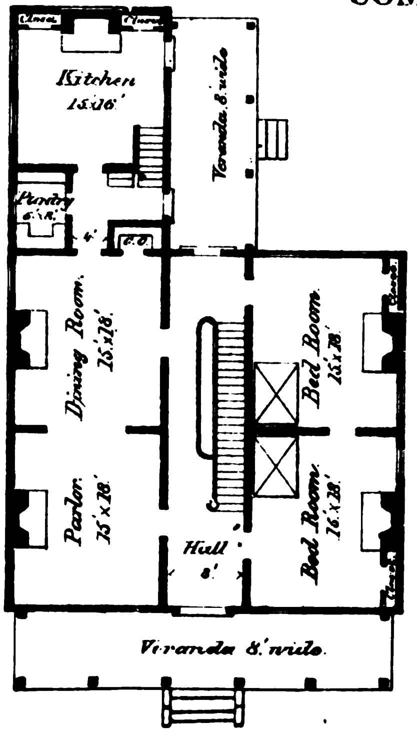


Plan of 2d. Story.

Scale 20 feet to 1 inch.

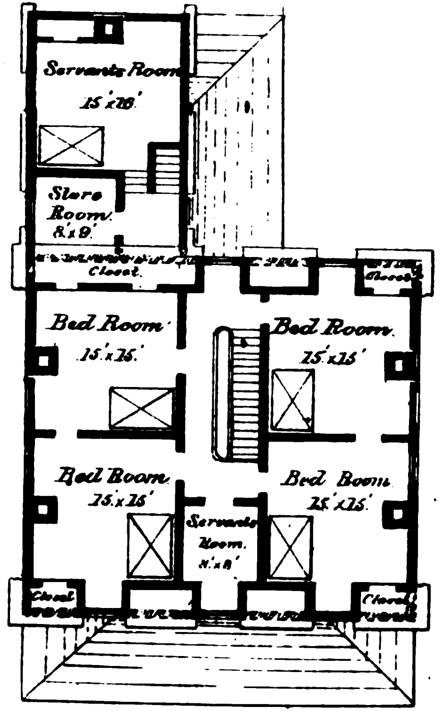
No. 4.

COMMANDING OFFICER'S QRS.



Plan of 1st Story.

Front Elevation.

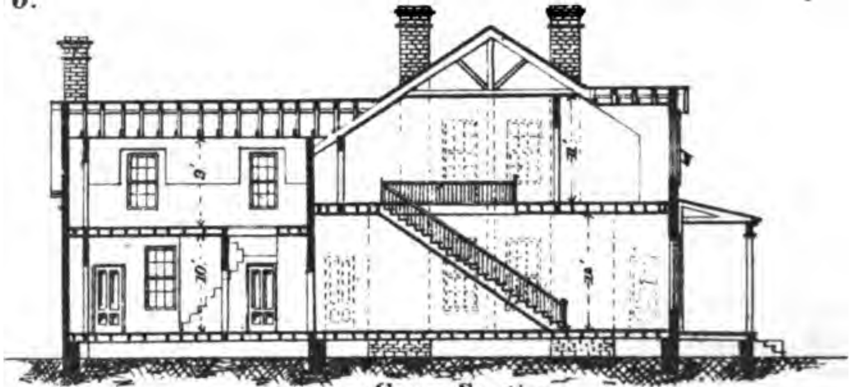


Plan of 2d Story.
or
Attic.

Scale 20 feet to 1 inch.

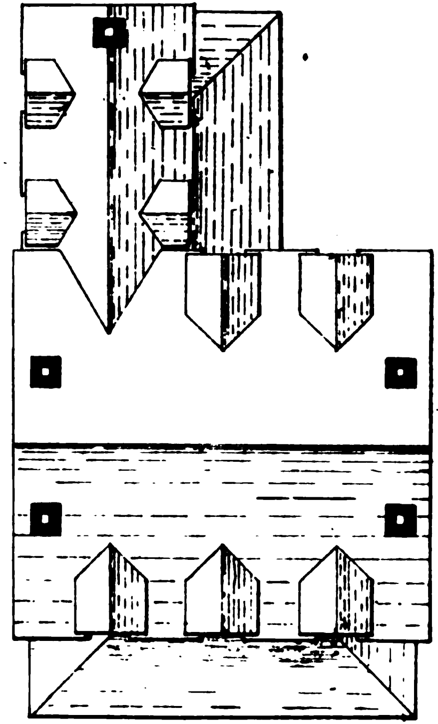
No 5.

COMMANDING OFFICERS QUARTERS.



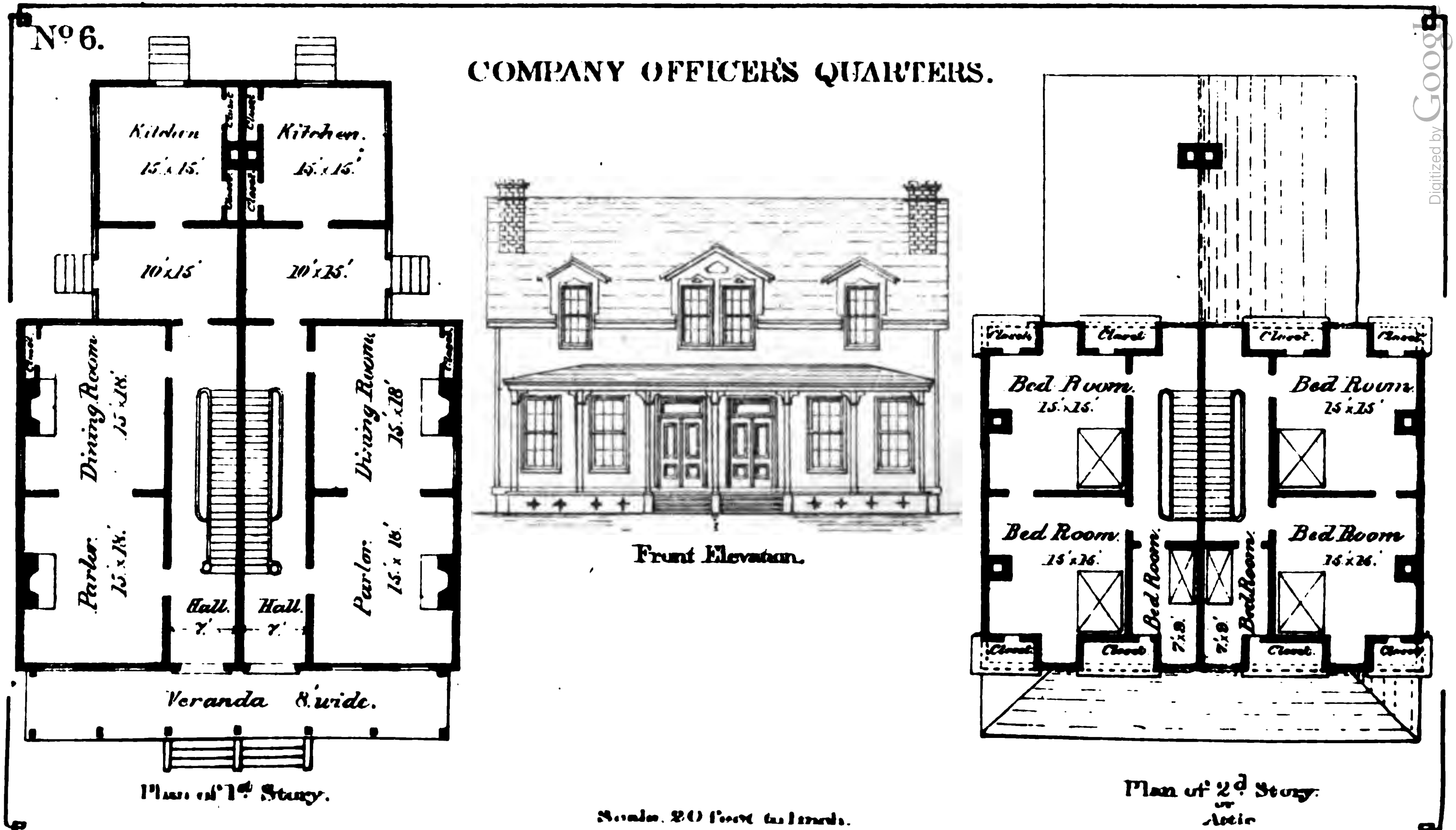
Cross Section.

Side Elevation.



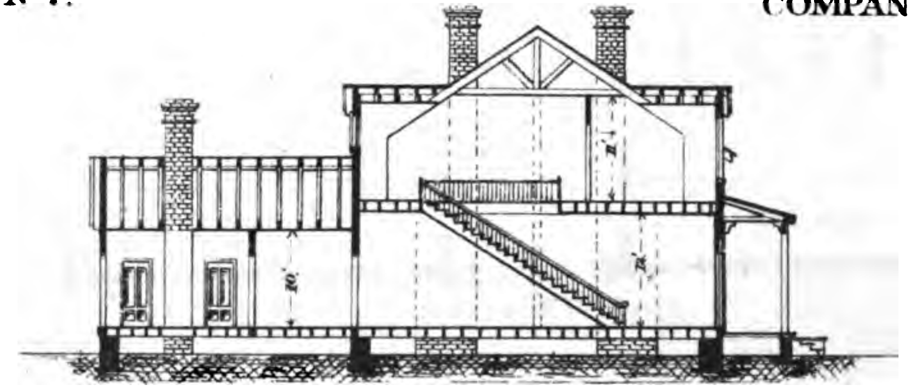
Plan of Roof.

Scale. 20 feet to 1 inch.

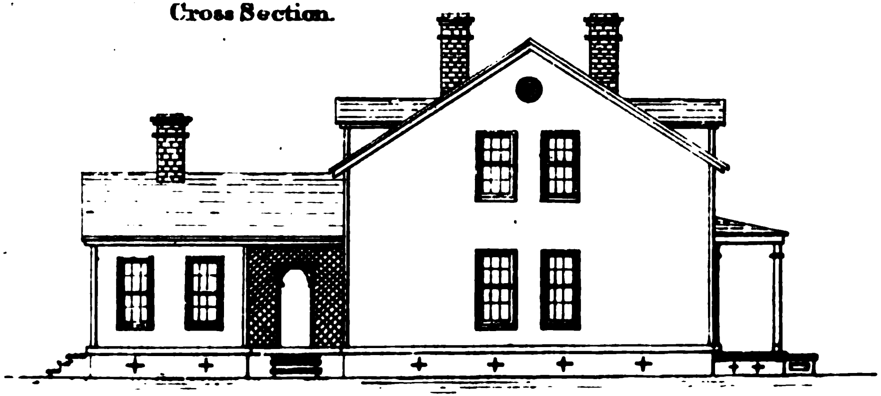

No 6.
COMPANY OFFICER'S QUARTERS.
Kitchen 15'x15'
Kitchen 15'x15'
10'x15'
20'x15'
Dining Room 15'x18'
Dining Room 15'x18'
Parlor 15'x18'
Parlor 15'x18'
Hall 7'
Hall 7'
Veranda 8' wide.
Plan of 1st Story.
Front Elevation.
Bed Room 15'x15'
Bed Room 15'x15'
Bed Room 15'x16'
Bed Room 15'x16'
Bed Room 7'x8'
Bed Room 7'x8'
Closet
Plan of 2d Story or Attic
Scale 20 feet to inch.

No 7.

COMPANY OFFICER'S QUARTERS.



Cross Section.

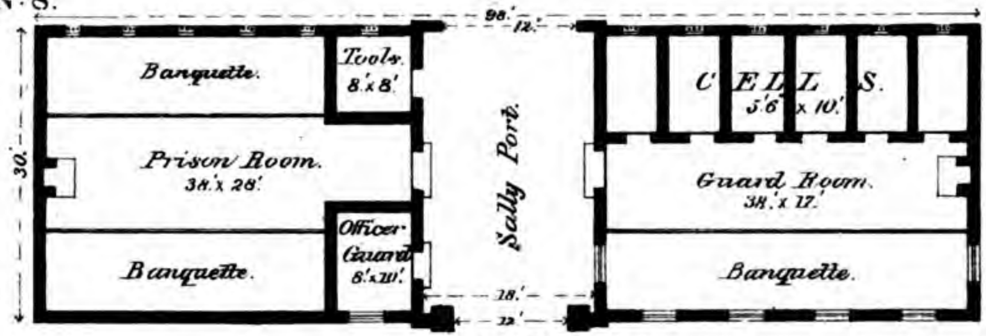


Side Elevation.

Rear Elevation.

Scale. 20 feet to 1 inch.

N°8.



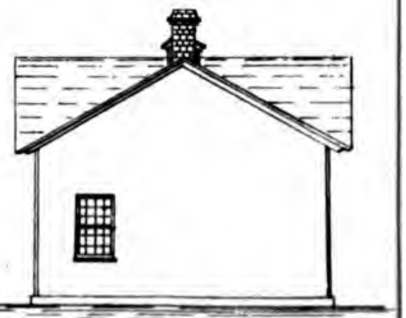
Plan of 1st Story.

Cross Section.

GUARD HOUSE.

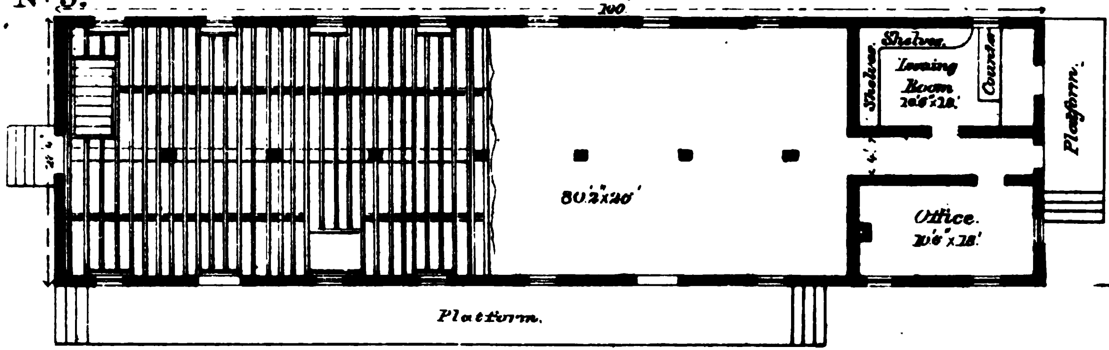
Scale 20 feet to 1 inch.

Front Elevation

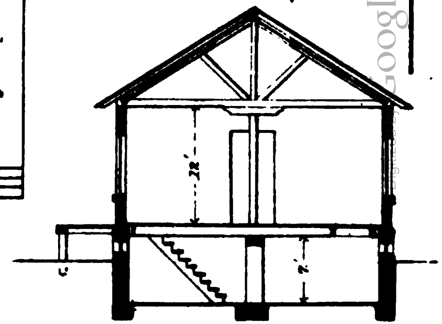


End Elevation.

No. 9.



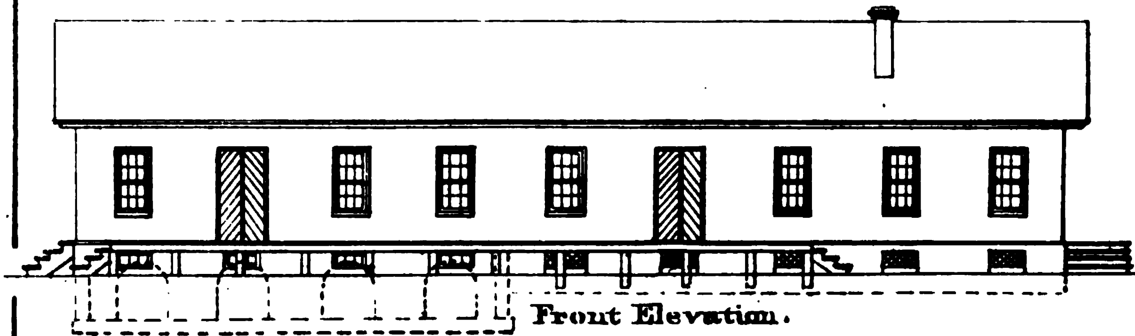
Ground Plan.



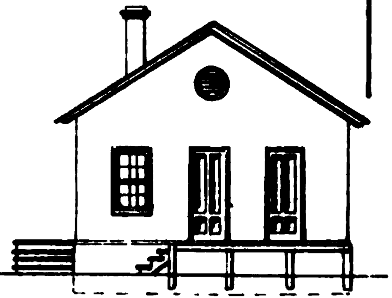
Cross Section.

COMMISSARY STORE HOUSE.

Scale. 20 feet to 1 inch.



Front Elevation.

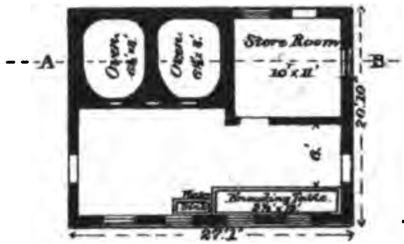


End Elevation.

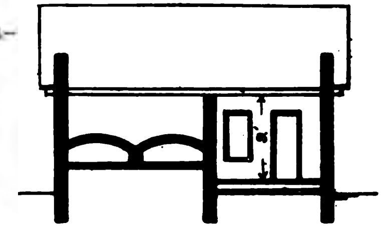
No. 10.

BAKE HOUSE.

Scale. 20 feet to 1 inch.

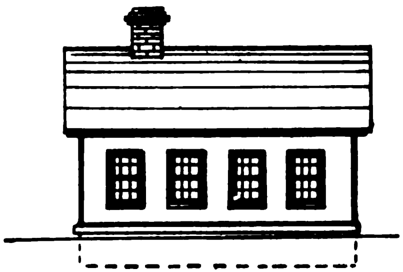


Ground Plan.

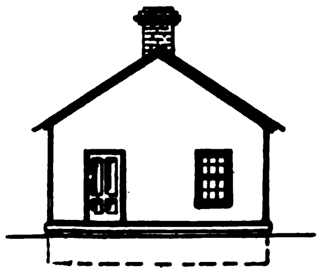


Section through. A.B.

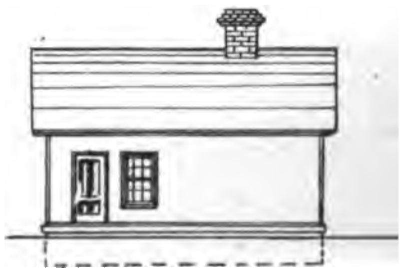
Front of Oven.



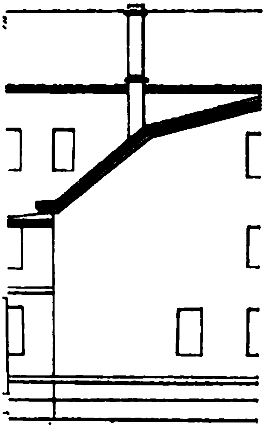
Front Elevation.



End Elevation.



Rear Elevation.



Gable

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Washington Aug 24th 75
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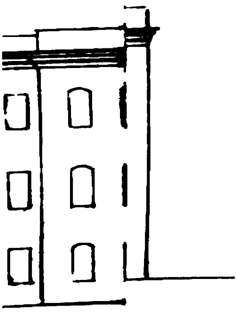


...timate...

F.

Estimate of cost of proposed soldiers' barracks at Fort Monroe, Va.

Description of workmanship and materials.	Quantities.	Rate.	Amount.
Foundations, floors of basement, pavement under verandas and through posterns, béton coignet......cubic yard..	922	$6 00	$5,532 00
Walls, chimneys, arches, second, third, and fourth floors, béton coignet, cubic yard	7,122	8 00	56,976 00
Granite corbels for supporting iron beams of 2d, 3d, and 4th floors, put in place......No..	442	5 00	2,210 00
Wrought-iron beams for girders and floor-beams for supporting arches, put in place......pounds..	406,885	07½	30,516 37
Refined iron, one and one-eighth inches by one and one-eighth inches, for ties of beams, including workmanship and putting up......pounds..	4,662	05	231 00
Refined iron, two inches by one-half for straps over girders, workmanship and putting up......pounds..	2,974	05	148 70
Cast-iron columns supporting girders ......No..	50	30 00	1,500 00
Roof; the top tinned and the sides slated......superficial feet..	32,041	30	9,612 30
Cornice and border for towers......running feet..	596	65	387 40
Upper cornice, main roof......running feet..	928	1 00	928 00
Large lower cornice......running feet..	1,191	2 50	2,977 50
Down spouts......running feet..	630	75	472 50
Wrought-iron verandas, one-inch, two-inch, and three-inch floors, with railing for second and third floors......running feet..	381	42 18	16,070 58
Iron stairs for rear towers, including hand-rail, complete......running feet..	408	25 30	10,322 40
Iron stairs for front to lecture-room on fourth floor, including rail, complete......running feet..	84	17 60	1,478 40
Freight on verandas and stairs from Philadelphia to Old Point, and fitting up......	......	......	7,875 00
Yellow-pine flooring for second, third, and fourth floors, including workmanship ......superficial feet	58,051	10	5,805 10
Yellow-pine flooring for verandas, second and third floors, including workmanship......superficial feet..	10,692	08	855 36
Window-frames complete......No..	36	20 00	720 00
Window-frames complete ......No..	8	15 00	120 00
Window-frames complete	72	14 00	1,008 00
Window-frames complete, three feet by six feet nine inches......	216	10 00	2,160 00
Window-frames complete, four feet by six feet nine inches......	6	12 00	72 00
Doors and frames complete, four feet by seven feet three inches......	5	15 00	75 00
Doors and frames complete, three feet by seven feet three inches......	102	14 00	1,428 00
Window-frames complete	18	75 00	1,350 00
Window-frames complete......	4	20 00	80 00
Window-frames complete	14	10 00	140 00
Window-frames complete......	92	30 00	2,760 00
Twelve water-tanks, fifteen feet by eleven feet by three feet, of one-eighth sheet-iron ......pounds..	19,395	16	3,103 20
Two hundred and eighty-eight basins for wash-rooms......No. of rooms	18	50 00	900 00
Sinks for kitchens......No..	6	5 00	30 00
Supply, overflow, and waste pipes for tanks, basins, bath-tubs and sinks......running feet..	2,106	50	1,053 00
Ranges for kitchens......No..	6	150 00	900 00
Bath tubs ......No..	24	20 00	480 00
Steam-heating apparatus	......	......	5,000 00
Scaffolding, arch-centering, painting, &c......	......	......	6,540 38
			181,818 19
Contingencies at 10 per cent......	......	......	18,181 81
Total for béton structure......	......	......	200,000 00
Additional expense if brick-work (estimated at $17 per cubic yard) be used in outer walls (two bricks and air-space thick), partitions, chimneys and ventilators, and floor-arches, with 10 per cent. for contingencies	......	......	50,000 00
Total for brick structure......			250,000 00

45TH CONGRESS, 2d Session. } HOUSE OF REPRESENTATIVES. { Ex. Doc. No. 44.

STURGEON BAY AND LAKE MICHIGAN SHIP-CANAL.

LETTER

FROM

THE SECRETARY OF WAR,

TRANSMITTING

Report of the engineer on the improvements of Sturgeon Bay and Lake Michigan Ship-canal and Harbor.

FEBRUARY 6, 1878.—Referred to the Committee on Commerce and ordered to be printed.

WAR DEPARTMENT, WASHINGTON CITY,
February 5, 1878.

The Secretary of War has the honor to transmit to the House of Representatives, in response to House resolution dated the 17th ultimo, requesting "the latest information relative to the improvements made on the Sturgeon Bay and Lake Michigan Ship-canal and Harbor up to the close of season's operation of 1877," the report of the Chief of Engineers and copy of a report of Maj. H. M. Robert, Corps of Engineers, on the subject.

The resolution referred to is also transmitted herewith.

GEO. W. McCRARY,
Secretary of War.

The SPEAKER *of the House of Representatives.*

OFFICE OF THE CHIEF OF ENGINEERS,
Washington, D. C., January 31, 1878.

SIR: The resolution of the House of Representatives of January 17, 1878, "that the Secretary of War be requested to procure the latest information relative to the improvements made on the Sturgeon Bay and Lake Michigan Ship-canal and Harbor up to the close of season's operations of 1877, and furnish the same to the House as soon as practicable," referred to this office for report, is herewith respectfully returned.

To enable the honorable the Secretary of War to comply with its requirements, I beg leave to transmit herewith a report on the subject from Maj. H. M. Robert, Corps of Engineers, the officer in whose district the canal referred to lies, which report, it is believed, will furnish the information desired.

Very respectfully, your obedient servant,

A. A. HUMPHREYS,
Brig. Genl., and Chief of Engineers.

HON. GEO. W. McCRARY,
Secretary of War.

IMPROVEMENT OF STURGEON BAY AND LAKE MICHIGAN SHIP-CANAL AND HARBOR.

UNITED STATES ENGINEER OFFICE,
Milwaukee, Wis., January 25, 1878.

GENERAL: In compliance with instructions contained in your letter of the 19th instant, referring to me the resolution of the House of Representatives calling for information "relative to the improvements made on the Sturgeon Bay and Lake Michigan Ship-canal and Harbor up to the close of season's operation of 1877," I have the honor to submit the following report:

Learning last summer that the Sturgeon Bay and Lake Michigan Ship-canal and Harbor Company were vigorously prosecuting the work, I visited the scene of operations last September, in order to ascertain, among other things, what were the probabilities of the canal's ever being completed. While the canal is in no way under government control, yet upon its completion depends the advisability of continuing work on the government piers near the mouth of the canal.

As the result of this examination, the work being about half completed, my own opinion was favorable to the probability of the early completion of the canal. The most serious cause of doubt was the following fact reported by the commissioners appointed by the State of Wisconsin in 1876 to examine into this very question:

Your commission believe that the first and second class lands were appraised too low, and the third and fourth class too high. Inasmuch as the company selected almost entirely from first-class lands, we believe they have obtained a patent for more than one-fourth in value of the entire grant. We arrive at this conclusion from the testimony taken, which proves that a large amount of the land classified as third and fourth class is worthless, containing no pine, and being unfit for agricultural purposes, and that a considerable portion of the first and second class land is worth more than the average price fixed by the appraisers. [See annual report of the secretary of state of Wisconsin for 1876, page 53.]

On this account I was anxious to see what the State would do this year about the land-grant. On November 26 the State inspector, Mr. John Nader (who was one of the commissioners above referred to), wrote me as to the results of his survey and inspection of the canal just made, as follows:

I made a very thorough personal survey and very careful estimates, and find that there is done to exceed one-half the entire work, the amount of 58,100 cubic yards. I obtain this by computing the amount yet to be done, making due allowance for contingencies, and deducting 10 per cent. of what was done since last inspection (on account of its unfinished state), and deducting from inspector's estimate. I consider this a reasonable margin for the safety of the State, and sufficient warrant for continuance of the work. The progress has been greater than I or the company's officers supposed it to be. The lumbering interests of some of the stockholders would now be an incentive to complete the work. The governor is absent; I will inform you further when he returns.

And again, on the 11th of January, he wrote as follows:

The governor has issued certificate for the second quarter in quantity of the "grant," on the decision and by advice of the supreme court and the attorney-general. I think, however, that the work will go on, as the same is sufficiently advanced to warrant its continuance.

I herewith transmit a copy of the full report of the State inspector to the governor, and also a communication from Mr. William T. Casgrain, the engineer of the canal company, showing what has been done since the date of the State inspection, and a map.

In conclusion, I would say that I think it exceedingly probable that the canal will be open for navigation by the close of the season of 1879. The outside harbor, being built by the government, should be completed about the same time.

No appropriation has been made by Congress for the harbor of refuge

since 1874, the appropriation then made being for the year ending June 30, 1875. My predecessor, Major Houston, stated that $60,000 would be required for the next fiscal year, provided the work on the canal, which had been suspended, be continued. For the next year (1876–'77) I recommended $40,000, provided the work was resumed, and since then have only asked for $5,000 for repairs. The original estimate for this work was $180,000, of which $50,000 has already been appropriated. Of the remaining $130,000 I would now recommend that $60,000 be appropriated, to be made available as soon as possible.

Very respectfully, your obedient servant,

HENRY M. ROBERT,
Major of Engineers, U. S. A.

Brig. Gen. A. A. HUMPHREYS,
Chief of Engineers, U. S. A.

LETTER OF MR. WILLIAM T. CASGRAIN, ENGINEER STURGEON BAY CANAL COMPANY.

OFFICE OF THE STURGEON BAY AND LAKE MICHIGAN
SHIP CANAL AND HARBOR COMPANY,
Milwaukee, January 24, 1878.

SIR: I have the honor to submit herewith for your information the report of Mr. John Nader, civil engineer, inspector to his excellency Harrison Ludington, governor of Wisconsin, relative to the completion of the second quarter of the work on the canal.

More than one-half of the work had been done on November 14, 1877, at which time the inspection was made, and the condition of the work is fully described by Mr. Nader.

Since this report was made there has been removed 9,500 cubic yards, and the distance between the waters is 1,450 feet.

The contract for the entire work has been awarded to O. B. Green, esq., of Chicago, who has agreed to complete the canal on or before the 1st of December, 1879. Mr. Green has now on the work all the necessary machinery to complete the canal according to the terms of the contract.

I would respectfully call your attention to the fact that, owing to the small amount of appropriations made from time to time by Congress for the construction of the piers to protect the lake entrance to the canal, it will take at least five years to complete these works, and the canal is likely to be available before the United States works are finished.

Preparations should also be made for the construction of the necessary light-houses and beacons in Sturgeon Bay and at the lake entrance to the canal.

Very respectfully,

WM. T. CASGRAIN,
Engineer Sturgeon Bay Canal Company.

Maj. H. M. ROBERT,
Corps of Engineers, U. S. A.

REPORT OF MR. JOHN NADER, INSPECTOR.

MADISON, WIS., *November* 23, 1877.

SIR: I have the honor to inform you that in accordance with your instructions of November 9, 1877, I have made an examination and survey of the work of the Sturgeon Bay and Lake Michigan Canal, and beg leave to submit the following report:

Taking as a basis the quantities estimated by Mr. Leonard Martin, inspector for the first quarter in September, 1873, I find that the work done since that time is considerable in excess of one-quarter, and that the Sturgeon Bay and Lake Michigan Ship Canal and Harbor Company is entitled to the benefits of a second quarter of work completed.

My estimates are based upon the same dimensions as those of the first inspector, viz. 100 feet width at the water-line, with slopes of 2 base to 1 perpendicular, and 13 feet depth of water, the plane of reference being taken at the level of the lowest water of 1847, the same being the lowest on record by $\frac{7}{10}$ feet.

On arriving at the work and observing the progress made, I concluded to ascertain the amount remaining undone, in order to determine the exact progress of the work.

The contract for the entire work was let to Mr. O. B. Green, of Chicago, at the commencement of the season, and is conducted under the supervision of the efficient chief engineer, Capt. William T. Casgrain. The facilities rendered by these gentlemen enabled me to make a complete survey of the bay and canal.

Three lines of soundings were taken in the cut of the canal, and in Sturgeon Bay as far as deep water, also levels on cross-sections of the canal at intervals of 50 feet. Soundings and levels were reduced to the plane of the lowest water of 1847, and compared exactly with the engineer's recorded notes.

A line of check-levels along the reference-marks upon which the work is based, exhibited only a difference within the limits of probable and admissible errors.

I estimate the following amount of work remaining undone November 14, 1877:

	Cubic yard
From Sturgeon Bay to high-water line, Lake Michigan	297,000
Excavation from bermes and drains	37,000
Excavation in mouth of canal, Lake Michigan	15,000
Excavation in Sturgeon Bay to deep water	54,000
Excavation for incomplete work to date	31,700
Total remaining undone	434,700

Inspector's estimate for 1873 was—

For clearing and grubbing 600 feet wide	38,400
For excavation in bay and canal	960,000
Total estimate of entire work	998,400

The clearing and grubbing was reduced from 600 feet to 400 feet wide, which made a proportional difference in quantities, as follows:

Clearing and grubbing	25,600
Excavation	960,000
Revised total estimate of entire work	985,600
Total done September 4, 1873 (from inspector's report)	255,000
Remaining undone September, 1873	730,600
Remaining undone November 14, 1877	434,700
Leaving a difference of	295,900
From which deduct clearing and grubbing	10,600
Excavation done since September, 1873	285,300

Total of all work since September, 1873	295,900
Estimate of work done September, 1873	255,000
Total of work done to November 14, 1877	550,900
One-half of revised total estimate	492,800
Leaving an excess over two-fourths	58,100
Remaining practically undone November 14, 1877	434,700

The first estimates were very properly made a little in excess to meet contingencies, as the nature of the material, although pretty thoroughly explored, might not have been found as stable as it proved to be. This excess of estimate has been nearly eliminated by the method adopted by me, that of measuring the quantities actually remaining undone, but will leave a corresponding discrepancy between my results and the engineer's measurements of perhaps 5,000 cubic yards, the difference being on the safe side.

The condition of the work is as follows:

From a point one mile out in Sturgeon Bay to the canal there is an average depth of 10 feet; from the head of the bay to station 3,100 feet southeast in canal, the cut is full width and average depth of water over 11 feet; thence to station 3,700 feet, the cut is two-thirds width and average depth of over 7 feet; thence to station 5,600 feet, a distance of 1,900 feet, there remains to be cut an average of 23 feet from the surface to obtain 13 feet of water;

thence to station 6,000 feet, the cut is two-thirds width and average depth of 5 feet of water; thence to station 6,500 feet, the cut is full width and average depth of 7 feet of water; thence to station 7,300 feet, at high-water line of Lake Michigan, the cut is two-thirds width and average depth of 5 feet water. The above depths of water represent the depth below the lowest water of 1847.

The work of the season was not begun until July. Since that time it was pushed forward with energy and determination. Four excellent Osgood dredges and three steam derricks were almost in constant operation to their utmost capacity.

The slopes and banks are in an unfinished condition, the principal object being to remove as much as possible of the heavy excavation during the season. In advance of the dredges, the surface excavation was removed with wheelbarrows, road-scrapers, and portable railroad.

The material removed was placed in spoil-banks not nearer than 20 feet to the top slope-stakes, so as to prevent a crowding of the banks.

From the present advanced condition of the work, it is safe to say that if the same be continued with the same degree of energy as it has during the past season, the 1st of July, 1878, will witness the canal open for the passage of tugs, dredges, and the smaller class of vessels.

The United States have under construction, but far from completion, an outer harbor on the lake end for the protection of the outlet of the canal, and also to serve as a harbor of refuge. This should he completed as early as possible, as it may be otherwise difficult to keep the canal open.

The company will be under the necessity of constructing pile and sheet-pile piers at the outlet, and for several hundred feet back into the canal, to prevent the waves from washing down the banks; otherwise, the banks, which appear to withstand very well the action of the waves from the tugs, will need no further protection for some time after the canal has become navigable, as may be seen from Colonel Houston's report to the Chief Engineer, U. S. A.

The dumping-grounds for scow work are on both sides of the bay, and are far from the line of channel. The material in the bay is soft mud, and the slopes to the channel will have to be very small to prevent sliding of the material into the cut.

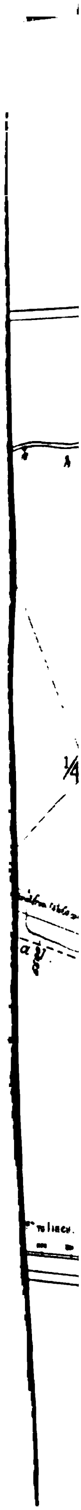
In conclusion, I would say that it is possible, when once the water flows through the canal, the mud in the head of the bay, which will be stirred up by the action of boats, will tend to form a cementing material to the sand-banks of the canal that may give a stability which will render other protection unnecessary.

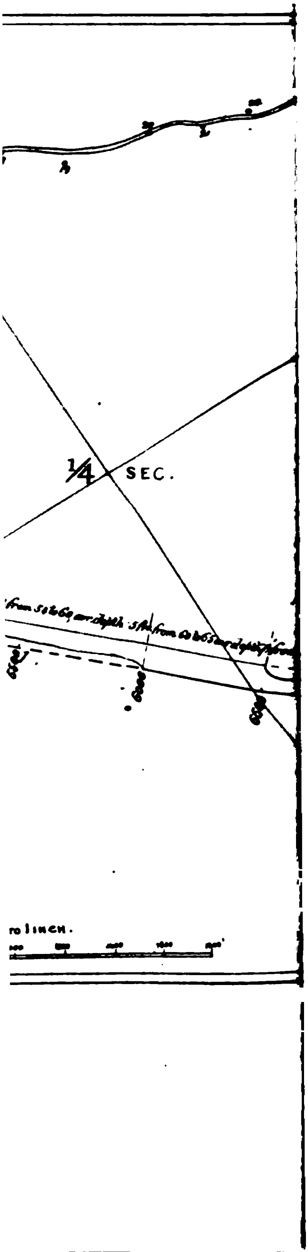
I submit herewith a map showing location and progress of canal, November 1877, and depth of water in canal and Sturgeon Bay.

I am, most respectfully, your obedient servant,

JOHN NADER,
Civil Engineer, Inspector.

To His Excellency, HARRISON LUDINGTON,
Governor of Wisconsin.

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45TH CONGRESS, } HOUSE OF REPRESENTATIVES. { EX. DOC.
2d Session. } { No. 45.

DEFICIENCIES IN APPROPRIATIONS FOR 1878, AND PRIOR YEARS.

LETTER

FROM

THE SECRETARY OF THE TREASURY,

TRANSMITTING

Estimates of deficiencies in appropriations for the year* 1878, *and prior years.

FEBRUARY 8, 1878.—Referred to the Committee on Appropriations and ordered to be printed.

TREASURY DEPARTMENT,
Washington, D. C., February 6, 1878.

SIR: I have the honor to transmit herewith the estimates of appropriations required by the various Departments to complete the service of the fiscal year ending June 30, 1878, and prior years, amounting to $2,678,820 04.

Very respectfully,
JOHN SHERMAN,
Secretary.

HON. SAMUEL J. RANDALL,
Speaker House of Representatives.

Estimates of appropriations required by the various Departments to complete the service of the fiscal year ending June 30, 1878, and prior years.

General object. (Title of appropriation.)	Detailed objects of expenditure, and explanations.		Date of acts, resolutions, or treaties, authorizing or providing for the expenditures.	References to Statutes at Large, or to Revised Statutes. Vol. or R. S.	Page.	Sec.	Estimated amount which will be required for each detailed object of expenditure.	Total amount to be appropriated under each head of appropriation.	Amount appropriated for the fiscal year for which the appropriation is required.
	DEPARTMENT OF STATE.								
	FOREIGN INTERCOURSE.								
Salaries, consular service.	For salaries of consuls-general, consuls, vice-consuls, commercial agents, and clerks, being deficiencies, as follows:								
	For the fiscal year 1871, and prior years		July 11, 1870	16	219	1	....	$494 62	$376,663 00
	For the fiscal year 1873		May 22, 1872	17	143	1	....	333 75	426,000 00
	For the fiscal year 1874		Feb. 22, 1873	17	472	1	....	1,150 82	419,000 00
	For the fiscal year 1875		June 11, 1874	18	67	1	....	1,354 20	364,500 00
	To effect a transfer of accounts in the State Department, under appropriations for consular salaries, involving no expenditure of money from the Treasury, as follows:								
	For the fiscal year 1872	$187 50							
	For the fiscal year 1873	2,145 60							
	For the fiscal year 1874	1,355 99							
	For the fiscal year 1875	6,696 25							
	To adjust the accounts of F. M. Cordeiro, (an alien,) United States vice-consul at Rio de Janeiro, for salary from April 25, 1871, to August 15, 1872, being a deficiency for the fiscal year 1872 of $655 06; and to effect a transfer of his accounts, involving no expenditure of money from the Treasury, being for the fiscal year 1871, and prior years, $543 96; for the fiscal year 1872, $5,157 44; and for the fiscal year 1873, $586 95		Feb. 21, 1871	16	417	1	....	655 06	391,200 00
	NOTE.—There was no provision made for the payment of salaries of consular officers not citizens of the United States for the fiscal years 1871, 1872, and 1873, and under the law the accounts of Mr. Cordeiro could not be paid from the appropriations for consular salaries for those years. By an act of Congress of December 17, 1872, (17 Stat., p. 709,) the accounting officers of the Treasury were authorized and directed to settle with Mr. Cordeiro as acting consul at Rio de Janeiro, and to pay him from the appropriation for salaries of consuls. The foregoing estimate for services as vice-consul is submitted for similar legislation.								

Contingent expenses of consulates.	For stationery, book-cases, arms of the United States, seals, presses, and flags, rent, freight, postage, and miscellaneous items, being deficiencies, as follows:								
	For the fiscal year 1872		Feb. 21, 1871	16	418	1		603 30	60,000 00
	For the fiscal year 1874		Feb. 22, 1873	17	473	1		70 05	100,000 00
	For the fiscal year 1875		June 11, 1874	18	70	1		117 95	131,850 00
	To effect a transfer of accounts in the State Department, under appropriations for contingent expenses of consulates, involving no expenditure of money from the Treasury, as follows:								
	For the fiscal year 1871	$38 97							
	For the fiscal year 1874	270 52							
	For the fiscal year 1875	182 34							
	For the fiscal year 1876	1,484 20							
	For the fiscal year 1877	14,169 51							
Salaries, interpreters to consulates in China, Japan, and Siam.	To effect a transfer of accounts in the State Department, involving no expenditure of money from the Treasury, viz: For salaries of interpreters to consulates in China, Japan, and Siam, being for the fiscal year 1871, and prior years, $542 87.								
Relief and protection of American seamen.	For relief and protection of American seamen in foreign countries, being deficiencies, as follows:								
	For the fiscal year 1871		July 11, 1870	16	220	1		104 25	10,000 00
	For the fiscal year 1872		Feb. 21, 1871 May 18, 1872	16 17	419 124	1 1		24 80	200,000 00
	For the fiscal year 1873		May 22, 1872	17	144	1		60 00	80,000 00
	For the fiscal year 1874		Feb. 22, 1873	17	474	1		20 00	100,000 00
	To effect a transfer of accounts in the State Department, under the appropriation for relief and protection of American seamen, involving no expenditure of money from the Treasury, being for the fiscal year 1872, $50 98.								
Bringing home criminals.	For bringing home from foreign countries persons charged with crimes, and expenses incident thereto, including loss by exchange, being a deficiency for the fiscal year 1872		Feb. 21, 1871	16	419	1		191 55	5,000 00
	Total State Department							5,270 44	2,664,213 00

UNDER THE COURT OF CLAIMS.

Payment of judgments	For the payment of judgments rendered by the Court of Claims due and unpaid February 6, 1878, with interest from date of presentation	Dec. 15, 1877, pamphlet laws.	R. S.	200	1089	$503,374 12	$639,370 59

NOTE.—For a list of these judgments, see Appendix, marked "A."

Estimates of appropriations required by the various Departments, &c.—Continued.

General object. (Title of appropriation.)	Detailed objects of expenditure, and explanations.	Date of acts, resolutions, or treaties, authorizing or providing for the expenditures.	References to Statutes at Large, or to Revised Statutes. Vol. or R. S.	Page.	Sec.	Estimated amount which will be required for each detailed object of expenditure.	Total amount to be appropriated under each head of appropriation.	Amount appropriated for the fiscal year for which the appropriation is required.
	TREASURY DEPARTMENT.							
	OFFICE OF SIXTH AUDITOR.							
Salaries, office of Sixth Auditor.	For twenty assorters of money-orders, $100 each, being a deficiency for the fiscal year 1878	March 3, 1875 March 3, 1877	18 19	397 301	2 1	....	$2,000 00	$18,000 00
	NOTE.—For explanation of this deficiency, see letter of Sixth Auditor, in Appendix, marked "B."							
	TERRITORIAL GOVERNMENTS.							
Legislative expenses, Territory of Dakota.	To pay balance due public printers for legislative printing, as adjusted by Comptroller of Treasury	Aug. 15, 1876	19	158	1	$1,076 25		
	Miscellaneous printing	do				100 00		
	Blanks and stationery	do				200 00		
	Pay of porter and care of public property, from March 1 to June 30, 1877, four months, at $40 per month	do				160 00		
	Rent of storerooms and office from January 1 to June 30, 1877, six months	do				250 00		
	Clerk-hire from January 1 to June 30, 1877, six months, at $50 per month	do				300 00		
	Fuel and lights	do				50 00		
	Postage	do				46 70		
	Balance due H. S. Bach, member of legislative assembly, per diem and mileage	do				197 00		
	Balance due J. Q. Burbank, member of legislative assembly, per diem, under ruling of Comptroller of Treasury, thirty days, at $6 per day	do				180 00		
	Balance due A. McHench, member of legislative assembly, per diem, under ruling of Comptroller of Treasury, thirty-seven days, at $6 per day	do				222 00		
	Incidental expenses of secretary's office, being deficiency for the fiscal year 1877	do				500 00	3,281 95	$20,000 00
	NOTE.—The secretary of the Territory states that he endeavored to conduct the affairs of his office with economy and efficiency, but found it to be impossible to pay the expenses he was obliged to incur from the appropriation at his disposal for the							

	fiscal year 1877. (See letter of the First Comptroller relative to this deficiency, in Appendix, marked "C.")							
Legislative expenses, Territory of Idaho.	To pay Milton Kelly for printing and binding 500 volumes of the revised and compiled laws of the Territory of Idaho, passed at the eighth session of its legislative assembly; being a deficiency for the fiscal year 1875	June 20, 1874	18	99	1	....	1,038 71	25,548 00
	NOTE.—It appears from the statement of the First Comptroller that the original bill for printing and binding for the session referred to was, after being reduced by measurement of specimens made in his office, $5,753 15, on which the territorial secretary paid but $2,056 44 out of the appropriation for the year 1875. An additional amount of $980 was paid on the bill by the Territory. A deficiency to the extent of $2,128 was granted by the act of July 31, 1876, which was intended to cover the balance of Mr. Kelly's bill, but it is now shown that said deficiency was insufficient to liquidate the claim by the sum of $588 71. To this latter amount the Comptroller states that $450 should be added for binding 300 copies of the laws of the eighth session, not allowed in previous measurement; making a total of $1,038 71 to be provided for by Congress.							
	Printing session laws of Idaho Territory, ninth session, 1876-'77, as per bill rendered to First Comptroller	Aug. 15, 1876	19	159	1	647 08		
	Executive legislative printing during session of 1876-'77, and allowed by the Comptroller of the Treasury	do				853 78		
	Printing journals of House of Representatives for 1876-'77	do				541 64		
	Printing journals of Council for 1876-'77	do				536 66		
	Porter for secretary's office during session, at $5 per day	do				200 00		
	Rent of secretary's office for one year, from July 1, 1876, to June 30, 1877, at $75 per month	do				900 00		
	Drayage during the session for 1876-'77	do				25 00		
	Rent of fire-proof warehouse for storing Government property, for the fiscal year ending June 30, 1877, at $40 per month	do				480 00		
	Printing for secretary's office for fiscal year 1877	do				125 00		
	Incidental expenses to June 30, 1877	do				75 00		
	Shelving, and pigeon-holes and desk	do				150 00		
	To Frank Coffin & Co., for stoves, pipes, and fixtures, and for labor in fitting up halls for assembly, for 1876-'77	do				195 14		
	To B. M. Anderson, carpenter, for fitting up legislative halls for 1876-'77	do				312 00		
	To A. G. Ridnay, for clerical services in secretary's office during session, at $5 per day	do				200 00		
	To Louis Scholl, copying journals of House, at $5 per day	do				200 00		
	To William H. Ridnay, copying journals of Council, at $5 per day, being deficiency for the fiscal year 1877	do				200 00	5,641 30	20,000 00
	NOTE.—The secretary of Idaho Territory states that it is important that the amount of his estimate be appropriated, to meet the absolute wants of the public service. (A letter from the First Comptroller of the Treasury on the subject of this deficiency will be found in Appendix "D.")							

Estimates of appropriations required by the various Departments, &c.—Continued.

General object. (Title of appropriation.)	Detailed objects of expenditure, and explanations.	Date of acts, resolutions, or treaties, authorizing or providing for the expenditures.	References to Statutes at Large, or to Revised Statutes. Vol. or R. S.	Page.	Sec.	Estimated amount which will be required for each detailed object of expenditure.	Total amount to be appropriated under each head of appropriation.	Amount appropriated for the fiscal year for which the appropriation is required.
	TERRITORIAL GOVERNMENTS—Continued.							
Legislative expenses, Territory of New Mexico.	Balance due Manderfield & Tucker, as follows:							
	For printing for legislative assembly, 22d session, as per letter of the Comptroller of the Treasury of April 20, 1876.	March 3, 1875	18	358	1	$190 47		
	For printing laws in Spanish, legislative assembly, 22d session, 1875-'76, as per letter of the Comptroller of the Treasury of May 22, 1876; being a deficiency for the fiscal year 1876.	March 3, 1875	18	358	1	1,257 66	$1,448 13	$22,043 90
	NOTE.—For explanation of this estimate, see letter of First Comptroller, in Appendix, marked "E."							
Salaries, governor, &c., Territory of Utah.	Amount due S. B. Axtell, late governor of the Territory of Utah, for salary from February 2 to February 10, 1875, inclusive, as per certificate of the accounting officers of the Treasury Department; being a deficiency for the fiscal year 1875.	June 20, 1874	18	99	1		87 50	15,000 00
	NOTE.—From the statement of the First Comptroller it appears that the predecessor of Mr. Axtell was paid for the same period; but that previous to the approval of the act of May 1, 1876, territorial governors were paid from the date of their commissions, from which rule the payment of two salaries for the same period was inseparable in some cases. By the act of May 1, 1876, (19 Stat., page 43,) it is provided that "hereafter payment of salaries of all officers of the Territories of the United States appointed by the President shall commence only when the person appointed to any such office shall take the proper oath, and shall enter upon the duties of such office in such Territory; and said oath shall hereafter be administered in the Territory in which such office is held."							

Legislative expenses, Territory of Washington.	To pay the members and officers of both houses of the legislative assembly of the Territory of Washington per diem for two days, being a deficiency for the fiscal year 1878	March 3, 1877	19	309	1		656 00	20,000 00
	NOTE.—From a copy of a joint resolution of both houses of the legislative assembly, passed November 6, 1877, it appears that the appropriation of $20,000 made by the act of March 3, 1877, is sufficient to pay the per diem of members and officers and the necessary expenses of the session for thirty-eight days only, after deducting the sum allowed for printing and a small amount for incidentals. That important legislative matters rendered it necessary for the assembly to continue the session forty days from date of convening, (as allowed by law,) causing a deficiency of two days pay in the per diem of the members. Under these circumstances, and for the reason that the secretary of the Territory has used earnest efforts to make the appropriation for the fiscal year 1878 meet the expenditure, the First Comptroller recommends the deficiency.							
Legislative expenses, Territory of Wyoming.	**For** incidental expenses of secretary's office, **viz:**							
	Due Draper & Hammond, repairing stoves, &c.	Aug. 15, 1876	19	159	1	6 70		
	Due Sloan & Co., for ice					15 00		
	Due H. T. French, office-rent					200 00		
	Due Addoms & Glover, oil, sponges, &c					48 55		
	Due F. E. Warren, furniture, repairing, stationery, &c					182 58		
	Due Frank Tibbitts, water					2 25		
	Being a deficiency for the fiscal year 1877.						455 08	1,000 00
	NOTE.—The First Comptroller reports that the amount of $1,000 appropriated for legislative expenses of the Territory of Wyoming for the fiscal year 1877 has been expended by the territorial secretary and accounted for, and that he has examined this deficiency estimate and finds that none of the bills presented are embraced in his accounts. The deficiency is therefore recommended.							
	For pay of members and officers of the fifth legislative assembly, which session ended December 15, 1877, being a deficiency for the fiscal year 1878	March 3, 1877	19	309	1		4,574 37	20,000 00
	INTERNAL REVENUE.							
			R. S.	52	391			
			R. S.	604	3141, 3142			
			R. S.	605	3145			
Salaries and expenses of collectors of internal revenue.	**Salaries and expenses of collectors, being a deficiency for the fiscal year ending June 30, 1878**		R. S.	606	3150		40,000 00	1,800,000 00
		Feb. 8, 1875	18	309	13			
		March 3, 1875	18	310	2			
		Aug. 15, 1876	19	152	1			
		March 3, 1877	19	303	1			
		March 3, 1877	19	363	1			

Estimates of appropriations required by the various Departments, &c.—Continued.

General object. (Title of appropriation.)	Detailed objects of expenditure, and explanations.	Date of acts, resolutions, or treaties, authorizing or providing for the expenditures.	References to Statutes at Large, or to Revised Statutes. Vol. or R. S.	Page.	Sec.	Estimated amount which will be required for each detailed object of expenditure.	Total amount to be appropriated under each head of appropriation.	Amount appropriated for the fiscal year for which the appropriation is required.
	INTERNAL REVENUE—Continued.		R. S.	52	321			
			R. S.	154	827			
			R. S.	158	838			
			R. S.	607	3152			
			R. S.	607	3153			
			R. S.	607	3157			
			R. S.	616	3192			
			R. S.	617	3197			
Salaries and expenses of agents and subordinate officers of internal revenue.	Salaries, expenses, and fees of supervisors, storekeepers, agents, surveyors, gaugers, and miscellaneous expenses, being a deficiency for the fiscal year ending June 30, 1878		R. S.	619	3208			
			R. S.	624	3238	....	$150,000 00	$1,450,000 00
			R. S.	631	3264			
			R. S.	634	3267			
			R. S.	646	3312			
			R. S.	655	3341			
			R. S.	662	3369			
			R. S.	678	3427			
		March 3, 1875	18	351	1			
		Aug. 15, 1876	19	152	1			
		March 3, 1877	19	303	1			
	NOTE.—For explanation of these estimates, see Appendix, marked "F."							
Punishment for violation of internal-revenue laws	For detecting and bringing to trial and punishment persons guilty of violating the internal-revenue laws, or conniving at the same, including payments for information and detection of such violations, being deficiencies, as follows:							
	For the fiscal year 1876	March 3, 1875	18	352	1	....	5,000 00	100,000 00
	For the fiscal year 1878	March 3, 1877	19	303	1	....	20,000 00	55,000 00
	NOTE.—For explanation of the estimate for 1876, see Appendix, marked "G."							
	COAST SURVEY.							
Survey of the Atlantic and Gulf coasts.	For the continuation of the survey of the Atlantic and Gulf coasts of the United States, the triangulation towards the western coast, and furnishing points for State surveys, being a deficiency for the fiscal year 1878		R. S.	917	4681, 4691			
		March 3, 1871	16	508	1	....	105,000 00	250,000 00
		Appropriated	19	116	1			
		Appropriated	19	353	1			

Survey of the Western Pacific coasts.	For the continuation of the survey of the Pacific coasts of the United States, the triangulation towards the eastern coast, and furnishing points for State surveys, being a deficiency for the fiscal year 1878	R. S. Sept. 30, 1850 Appropriated	 9 19	917 541 353	4681, 4691 1 1	65,000 00	150,000 00
Vessel for the Coast Survey.	For one schooner for the observation of sea-currents and other work along the Atlantic and Gulf coasts of the United States.	Appropriated Submitted	18	378	1	23,000 00	
	MISCELLANEOUS.						
Contingent expenses, Treasury Department.	To pay vouchers submitted by the Atlantic and Pacific Telegraph Company, for telegrams during the years 1874 and 1875, being deficiencies, as follows:						
	For the fiscal year 1874	Appropriated	17	495	1	11 96	65,000 00
	For the fiscal year 1875	Appropriated	18	93	1	89 44	5,000 00
	For gas, drop-lights, and tubing; gas-burners, brackets, and globes; candles; and lanterns and wicks, being a deficiency for the fiscal year 1878	Appropriated	19	303	1	6,000 00	12,500 00
	For care and subsistence of horses for office and mail-wagons, including feeding and shoeing; and for wagons, harness, and repairs of same, being a deficiency for the fiscal year 1878	do.				2,000 00	3,200 00
	Miscellaneous items: To adjust the settled account of the Bureau of Engraving and Printing, Treasury Department, for printing commissions of revenue-marine officers, &c., involving no expenditure of money from the Treasury, being for the service of the fiscal year 1877, $63 80.						
	NOTE.—For explanation of the estimates for gas, and for horses and wagons, see Appendix, marked "H."						
Contingent expenses, Independent Treasury.	To adjust the settled account of the Bureau of Engraving and Printing, Treasury Department, being amount found due said bureau for paper boxes furnished to the Treasury Department, involving no expenditure of money from the Treasury, being for the service of the fiscal year 1877, $42 56.						
	For contingent expenses under the act of August 6, 1846, for the collection, safe-keeping, transfer, and disbursement of the public money, being a deficiency for the fiscal year 1878	March 3, 1877	19	306	1	10,000 00	50,000 00
Postage, Treasury Department.	For postage-stamps and over-due postage, being a deficiency for the fiscal year 1878	Appropriated March 3, 1877	19 19	303 319	1 2	800 00	200,000 00
Expenses of Louisiana Commission.	For expenses and compensation of the Commission appointed by the President to go to Louisiana, six thousand dollars, or so much thereof as may be necessary	Submitted				6,000 00	
Expenses of national currency.	Amount due Texas Banking and Insurance Company for transportation, as per certificate of the accounting officers of the Treasury Department, being a deficiency for the fiscal year 1873	June 10, 1872	17	348	1	25 35	100,000 00

Estimates of appropriations required by the various Departments, &c.—Continued.

General object. (Title of appropriation.)	Detailed objects of expenditure, and explanations.	Date of acts, resolutions, or treaties, authorizing or providing for the expenditures.	References to Statutes at Large, or to Revised Statutes. Vol. or R. S.	Page.	Sec.	Estimated amount which will be required for each detailed object of expenditure.	Total amount to be appropriated under each head of appropriation.	Amount appropriated for the fiscal year for which the appropriation is required.
	MISCELLANEOUS—Continued.							
Salaries, Commissioners to codify the laws of the United States.	Amount due B. Vaughn Abbott, on account of the Commission to revise the United States statutes, as per certificate of the accounting officers of the Treasury Department, being a deficiency for the fiscal year 1871, and prior years	July 15, 1870	16	311	1	....	$61 90	$15,000 00
Repairs and preservation of public buildings.	For repairs and preservation of public buildings under control the Treasury Department, being a deficiency for the fiscal year 1878	March 3, 1877	19	351	1	....	25,000 00	100,000 00
	NOTE.—For explanation of this estimate, see letter of the Supervising Architect, Appendix, marked "I."							
Customs service	For the settlement of balances due disbursing officers for expenditures made by them in pursuance of law, on account of the appropriations named below, being deficiencies, as follows:							
	Furniture and repairs of same for public buildings, fiscal year 1872	March 3, 1871	16	497	1	....	1 75	150,000 00
	Repairs and preservation of public buildings, fiscal year 1874	March 3, 1873 June 22, 1874	17 18	525 136	1 1	....	25 00	240,000 00
	Revenue-cutter service, fiscal year 1874	March 3, 1873	17	511	1	....	2 52	1,028,218 40
	Expenses of collecting the revenue from customs in 1875	....	R. S.	729	3687	....	234 23	6,841,370 76
	Custom-house, Machias, Maine	June 10, 1872	17	352	1	....	91	2,000 00
	Custom-house, Wiscasset, Maine	July 15, 1870	16	295	1	....	10 78	4,000 00
	For the settlement of disbursing officers' accounts under the control of the Commissioner of Customs, involving no expenditure of money from the Treasury, $55,696 69, being on account of appropriations for the service of several fiscal years, as shown in Appendix, marked "J."							
Lighting and buoyage of the Mississippi, Ohio, and Missouri rivers.	To reimburse the Evansville, Ohio, and Memphis Packet Company for maintaining lights on the Ohio river from July 1 to November 11, 1874, being a deficiency for the service of the fiscal year 1875	Appropriated	18	220	1	....	757 50	50,000 00

	NOTE.—By the act of June 23, 1874, (18 Stat., 220,) the jurisdiction of the Light-house Board was extended over the Ohio river; and the cost of maintaining lights generally useful to navigation should therefore be borne by the Government from the period when the act took effect. The amount estimated is calculated on the basis of the rate paid by the Light-house Board for maintaining similar aids to navigation. There is at present no appropriation from which this claim can be paid.							
Propagation of food-fishes.	To adjust the settled account of Marcus W. Lyon, lieutenant of ordnance and quartermaster, involving no expenditure of money from the Treasury, being for the service of the fiscal year 1876, $36.							
Suppressing counterfeiting and fraud.	To adjust the settled account of the Treasury Department for stationery furnished officers of the United States secret-service, involving no expenditure of money from the Treasury, being for the service of the fiscal year 1877, $18 22.							
Fort Ripley Light-station, S. C.	For building a light-house on Fort Ripley shoal, Charleston harbor, S. C., to take the place of the light now at Castle Pinckney, an additional appropriation of $5,000 is requested........	July 31, 1876	19	112	1	....	5,000 00	15,000 00
	NOTE.—The naval secretary of the Light-house Board reports that an examination of the causes leading to the destruction of the screw-pile light-houses in Matagorda bay, Texas, by the hurricane of September, 1874, has shown that it is necessary to modify the plans of the iron structure to be erected in Charleston harbor, S. C., and to be known as Fort Ripley Shoal light-house, for which an appropriation of $15,000 was made by act of July 31, 1876; and that this modification will entail an additional expenditure of $5,000.							
	Total Treasury Department..........................	....	....	.....	.....	....	483,204 38	12,847,881 06
	WAR DEPARTMENT.							
	NOTE.—Deficiency estimate for— Pay, travelling, and general expenses of the Army, 1878.............................. $450,551 33 Transportation of the Army and its supplies, 1877 .... 1,200,000 00 Medical and hospital department, 1877........ 2,500 00 Artificial limbs, 1878 .... 25,000 00 Were reported to Congress December 10, 1877, (see Ex. Doc. No. 18, House of Representatives, 45th Congress, 2d session.)							
Subsistence of the Army.	For subsistence of 378 men (in excess of 22,000 appropriated for) for 123 days, from July 1 to October 31, 1877, at 24 cents per day..	....	R. S.	223	1293	$11,158 56		

Estimates of appropriations required by the various Departments, &c.—Continued.

General object. (Title of appropriation.)	Detailed objects of expenditure, and explanations.	Date of acts, resolutions, or treaties, authorizing or providing for the expenditures.	References to Statutes at Large, or to Revised Statutes. Vol. or R. S.	Page.	Sec.	Estimated amount which will be required for each detailed object of expenditure.	Total amount to be appropriated under each head of appropriation.	Amount appropriated for the fiscal year for which the appropriation is required.
	WAR DEPARTMENT—CONTINUED.							
Subsistence of the Army—Continued.	For subsistence of 5,000 men (in excess of 20,000 appropriated for) for 242 days, from November 1, 1877, to June 30, 1878, at 24 cents per day		R. S.	223	1293	$290,400 00		
	For subsistence of 914 civilian employés (in excess of 2,000 estimated for in annual estimate) from August 1, 1877, to November 30, 1877, 122 days, at 24 cents per day	G. O., No. 59, Headquarters Army, 1877, paragraph I. Army Regs., par. 1201				26,761 92		
	For expenses to subsistence department of the Nez Percé war to November 25, 1877	Submitted				25,470 63		
	For subsistence to be issued to Nez Percé prisoners (467) for four months from November 26, 1877	do				9,002 55		
	For subsistence to be issued to Cheyenne, Arapahoe, Kiowa, and Comanche prisoners at St. Augustine, Fla., for twelve months, from July 1, 1877	do				4,330 08		
	Being a deficiency for the fiscal year 1878.						$367,123 74	$2,370,000 00
Transportation of the Army and its supplies.	For payment of amounts certified to be due by the accounting officers of the Treasury Department, for transportation of the Army, being—							
	For the service of the fiscal year 1873	June 6, 1872	17	260	1		451,096 34	4,000,000 00
	For the service of the fiscal year 1875	June 16, 1874	18	73	1		156,823 07	4,000,000 00
	NOTE.—For schedule of claims, see Appendix, marked "K."							
	Extract from Third Auditor's letter of December 31, 1877: "The aggregate under the appropriation for 'Army transportation for year ending June 30, 1873,' is made up as follows: "1st. Aggregate found due sundry persons, &c., for transportation service in that year, $837 88. "2d. Aggregate found due the four 'Pacific railroads, and payable to the Secretary of the Treasury, to be by him *withheld*, in pursuance of act of March 3, 1873, (Rev. Stat., 5260, '61,) viz:							

	Union Pacific Railroad Co. .... $313,654 03 Kansas Pacific Railroad Co. .... 86,369 40 Sioux City Pacific Railroad Co. .... 2,914 69 Central Pacific Railroad Co. .... 47,601 66 450,539 78 "So far as the amounts found due those four companies, an appropriation would involve *no actual expenditure* from the Treasury. The amounts would be, in form, drawn from the appropriation, on requisitions by the Secretary of War, and would be paid to the Secretary of the Treasury, who would redeposit them in the Treasury, and 'withhold' them, as required by law. This course, which has been pursued in the accounts for the other fiscal years, has not been possible in respect to the fiscal year 1872-'73, because, in the deficiency appropriation for that fiscal year, (18 Stat., Part 3, page 138,) Congress, by express provision, excluded the Pacific railroads from any part of the amount thereby appropriated; and the Secretary of War has, therefore, had no fund out of which he could make payment to the Secretary of the Treasury, as contemplated by law. "In order that the accounts for that fiscal year may be placed on the same footing with those for other years, it is hoped that Congress, in addition to providing for the sum allowed to sundry persons, &c., ($837 88,) will include, in the deficiency appropriation, a provision in substance as follows: 'For amounts earned by the Union Pacific, Kansas Pacific, Sioux City Pacific, and Central Pacific railroad companies, respectively, by transportation service in the fiscal year ending June 30, 1873, the aggregate sum of $450,539 78: *Provided, however*, That no part of such aggregate sum shall be paid to either of said companies, but the same shall be paid to the Secretary of the Treasury, to be by him withheld, as directed by existing law.'"							
	For transportation of the Nez Percé Indian prisoners from Bismarck to Leavenworth, Kansas, and from Leavenworth to Vinita, I. T., being for the fiscal year 1878	Submitted....	.....	.....	.....	....	16,356 06	
Barracks and quarters ...	For payment of amounts certified to be due by the accounting officers of the Treasury Department, for rent or hire of quarters for troops, and for officers on military duty, being for the service of the fiscal year 1871, and prior years .... NOTE.—For schedule of claims, see Appendix, marked "K."	July 15, 1870	16	317	1	....	33,433 44	750,000 00
Incidental expenses, Quartermaster's department.	For payment of amounts certified to be due by the accounting officers of the Treasury Department, for incidental expenses of the Army, being for the service of the fiscal year 1874..... NOTE.—For schedule of claims, see Appendix, marked "K."	March 3, 1873	17	544	1	....	7,996 76	1,300,000 00

Estimates of appropriations required by the various Departments, &c.—Continued.

General object. (Title of appropriation.)	Detailed objects of expenditure, and explanations.	Date of acts, resolutions, or treaties, authorizing or providing for the expenditures.	References to Statutes at Large, or to Revised Statutes. Vol. or R. S.	Page.	Sec.	Estimated amount which will be required for each detailed object of expenditure.	Total amount to be appropriated under each head of appropriation.	Amount appropriated for the fiscal year for which the appropriation is required.
	WAR DEPARTMENT—CONTINUED.							
Horses for cavalry and artillery.	For payment of amounts certified to be due by the accounting officers of the Treasury Department, for purchase of horses for cavalry and artillery, being for the service of the fiscal year 1871 and prior years	March 3, 1869	15	317	1	....	$9,902 86	$250,000 00
	NOTE.—For schedule of claims, see Appendix, marked "K."							
National cemeteries	For payment of amounts certified to be due by the accounting officers of the Treasury Department, for establishing and maintaining national cemeteries, being—							
	For the service of the fiscal year 1871, and prior years	July 15, 1870	16	317	1	....	181 36	300,000 00
	For the service of the fiscal year 1872	March 3, 1871	16	523	1	....	76 00	200,000 00
	For the service of the fiscal year 1875	June 16, 1874	18	74	1	....	18 00	150,000 00
	NOTE.—For schedue of claims, see Appendix, marked "K."							
Horses and other property lost in the military service.	For payment of amounts certified to be due by the accounting officers of the Treasury Department, for horses and other property lost in the military service	....	R. S.	732	3689	....	75,421 38	(Indefinite.)
	NOTE.—For schedule of claims, see Appendix, marked "K."							
Commutation of rations to prisoners of war in rebel States.	For payment of amounts certified to be due by the accounting officers of the Treasury Department, for commutation of rations to prisoners of war in rebel States	July 25, 1866 March 2, 1867	14 14	364 423	 3	....	1,348 75	(Indefinite.)
	NOTE.—For schedule of claims, see Appendix, marked "K."							
Ordnance service	For payment of amounts certified to be due by the accounting officers of the Treasury Department—							
	For the service of the fiscal year 1871, and prior years	July 15, 1870	16	317	1	....	102 75	150,000 00
	NOTE.—For schedule of claims, see Appendix, marked "K."							

Relief of certain musicians and soldiers for losses at Fort Sumter, in 1861.	For payment of amounts certified to be due by the accounting officers of the Treasury Department— For the service of the fiscal year 1871, and prior years.....	July 24, 1861	12	273	.....	....	15 00	1,150 00
	NOTE.—By act of July 24, 1861, (12 Stat., 273,) $1,150 was appropriated for this purpose; and it appears, from the books of this Department, that $194 of this amount remained unexpended, and was carried to the surplus fund, June 29, 1872. For schedule of claims, see Appendix, marked "K."							
Postage, War Department.	Postage on official mail-matter for the War Department and its bureaus, being for the service of the fiscal year 1878..........	Appropriated	19	319	2	....	50,884 50	80,000 00
	Postage on official mail-matter for the War Department and its bureaus, being for the service of the fiscal year 1879	Submitted.....	.....	....	.....	....	85,000 00	
	NOTE.—The law authorizes requisitions upon the Postmaster General for the necessary amount of postage-stamps for the use of the War Department and its bureaus, not exceeding the amount stated in the estimates submitted to Congress. The estimates for the fiscal year ending June 30, 1878, were $80,000; and for 1879, $80,000. These were based upon annual requirements subsequent to March 3, 1873, when departmental stamps and stamped envelopes, to be used only for official mail-matter, were introduced, (17 Stat., 542—19 Stat., 250,) the appropriations having been for the several succeeding fiscal years, as follows: 1873, franking privilege; 1874, $153,000; 1875, $120,000; 1876, $85,669; 1877, $80,612. The recent estimates did not anticipate extraordinary demands on this Department proper for postage, such demands having been occasioned by the delay of ordinary Army appropriations, by emergencies which required unusual movements of troops during this fiscal year, and by an omission of the ordinary allowance for postage in the appropriation for "Pay and travelling and general expenses of the Army" for this year. The departmental stamps and stamped envelopes are now principally used by officials other than those in Washington, as is suggested by the sixtieth paragraph of the rulings of the Post Office Department, the privilege to transmit in the mails, free of postage, letters, packages, or other matter being confined exclusively to matter sent from Washington, D. C., in accordance with the sixty-second paragraph of the same rulings. Prior to this fiscal year departmental stamps and stamped envelopes were not used by officials who were supplied through Army appropriation to the extent of $80,098 54, namely: From incidental expenses of the Quartermaster's department, about $5,500; from pay and travelling and general expenses of the Army, $74,598 54. At the commencement of this fiscal year the amount of postage-stamps on hand was $33,928 50; there was appropriated for this fiscal year, $80,000; total available, $113,928 50. There has been drawn upon requisition, up to January 1, 1878, $82,456 50,							

Estimates of appropriations required by the various Departments, &c.—Continued.

General object. (Title of appropriation.)	Detailed objects of expenditure, and explanations.	Date of acts, resolutions, or treaties, authorizing or providing for the expenditures.	References to Statutes at Large, or to Revised Statutes. Vol. or R. S.	Page.	Sec.	Estimated amount which will be required for each detailed object of expenditure.	Total amount to be appropriated under each head of appropriation.	Amount appropriated for the fiscal year for which the appropriation is required.
	WAR DEPARTMENT—CONTINUED.							
Postage, War Department—Continued.	and it is fair to presume that at least an equal amount will be needed for the remaining six months of the year, the amount needed being $82,456 50, less the balance on hand January 1, 1878, $31,472, showing the amount of deficiency for 1878, $50,884 50. On this showing it appears that the total amount required for 1878 will be $164,813. The estimate heretofore made for 1879 was for $80,000 only, and therefore the additional estimate for $85,000 for that year is submitted.							
	Total War Department						$1,255,780 01	$13,551,150 00
	INTERIOR DEPARTMENT.							
	OFFICE OF COMMISSIONER OF PATENTS.							
Contingent expenses, office of Commissioner of Patents.	Contingent and miscellaneous expenses, as follows: For constructing platform and cases on the south side of F-street wing for the reception of accruing models and those saved from the fire; reimbursement of contingent fund for incidental expenses for labor and materials in protecting the property of the office at the time of and subsequent to the fire; fitting up rooms and providing cases for specifications and drawings to be removed from the attic of the Patent-Office building; removal of the same; replacing and repairing furniture, cases, carpets, awnings, drawing-materials destroyed by fire and damaged by water; restoring and classifying damaged models; carpeting and furnishing rooms temporarily occupied by the Patent Office in Wright's building; additional temporary laborers, made necessary by the destruction, damage, and derangement of the files, models, drawings, and specifications, being a deficiency for the service of the fiscal year 1878	Appropriated	19	314	1		$43,600 00	$60,000 00

Copies of drawings, office of Commissioner of Patents.	Photo-lithographing, or otherwise producing copies of drawings of back issues, to replace, in part, those destroyed by fire, being a deficiency for the service of the fiscal year 1878	Appropriated	19	314	1		45,000 00	32,500 00
Photo-lithographing, office of Commissioner of Patents.	Photo-lithographing, or otherwise producing copies of the weekly issues of drawings to be attached to patents and copies, being a deficiency for the service of the fiscal year 1878	Appropriated	19	314	1		15,000 00	27,500 00
Plates for Patent Office Official Gazette.	Photo-lithographing, or otherwise producing plates for the Official Gazette, including pay of employés engaged on the Gazette, and for making similar plates, being a deficiency for the service of the fiscal year 1878	Appropriated	19	314	1		15,000 00	25,000 00
	NOTE.—For explanation of the estimates submitted by the Commissioner of Patents, see Appendix, marked "L."							
	OFFICE OF COMMISSIONER OF EDUCATION.							
Educational Museum, office of Commissioner of Education.	For necessary expenses in caring for and guarding the collection of educational appliances and apparatus in the Educational Museum of the Bureau of Education	Submitted					2,500 00	
Contingent expenses, office of Commissioner of Education.	For collecting statistics, writing and compiling matter for annual and special reports, centennial and others, and editing and publishing circulars of information	Appropriated	19	315	1	$7,000 00		
	Contingencies	do				575 00		
	Being deficiencies for the service of the fiscal year 1878.						7,575 00	8,500 00

NOTE.—The amount of $2,500 is necessary for the proper care of the Educational Museum of this office. It is at present stored in quarters that are not fire-proof. There is no person at present employed in taking care of the articles, which are many in number, varied in interest, and instructive in a very high degree; their condition requires constant attention.

The same reasons which render an increase in the estimate for the year ending June 30, 1879, for collecting statistics, &c., apply with equal force to the current fiscal year. Several interesting reports which have been begun cannot be completed within any reasonable time without additional means for the employment of the necessary workers and the payment of necessary expenses. If these are not completed within a reasonable time much of the labor already bestowed on them will be virtually thrown away, and the expectations of the correspondents of the office will be disappointed.

The additional sum of $575 for the current fiscal year on account of unforeseen contingent expenses is also thought to be necessary. The change of the official quarters at the close of the last fiscal year has required many small unusual expenses since, and has rendered this estimate necessary.

Estimates of appropriations required by the various Departments, &c.—Continued.

General object. (Title of appropriation.)	Detailed objects of expenditure, and explanations.	Date of acts, resolutions, or treaties, authorizing or providing for the expenditures.	References to Statutes at Large, or to Revised Statutes. Vol. or R. S.	Page.	Sec.	Estimated amount which will be required for each detailed object of expenditure.	Total amount to be appropriated under each head of appropriation.	Amount appropriated for the fiscal year for which the appropriation is required.
	GOVERNMENT HOSPITAL FOR THE INSANE.							
Current expenses, Government Hospital for the Insane.	Support, clothing, and medical and moral treatment of the insane of the Army, Navy, Marine Corps, and Revenue-cutter Service, and of all persons who have become insane since their entrance into the military or naval service of the United States, and who are indigent, and of the indigent insane of the District of Columbia, in the Government Hospital for the Insane; being a deficiency in the amount required for the support of the hospital for the fiscal year 1878	.... Appropriated	R. S. 19	945 347	4838, 4858 1	....	$9,583 00	$145,000 00
	NOTE.—The estimated sum required and asked for supporting the free or Government patients in the hospital, in accordance with the requirements of law, during the year ending June 30, 1878, was $160,426, less $5,843, the estimated one-half of the cost during that year of supporting the indigent insane of the District of Columbia, (as required by the appropriation acts of the last and preceding sessions of Congress,) $154,583. The amount appropriated for this object was $145,000, and the difference between the estimate and the appropriation is $9,583.							
Buildings and grounds, Government Hospital for the Insane.	For general repairs and improvements, being a deficiency for the fiscal year 1878	Appropriated	19	347	1	....	5,000 00	5,000 00
	NOTE.—The estimate for ordinary repairs and improvements was $10,000, and the appropriation was $5,000, and the difference is $5,000. Those estimates were designedly made very close, and the number of patients in the house during the first two months of the current year, 1877–'78, is larger than was anticipated, and the difference between the sums appropriated and the estimates is strictly a deficiency in the means required to provide what is necessary for the comfort and welfare of the inmates of the hospital and to keep the property of the Government devoted to the objects of this institution in good order and repair during the current year.							

	COLUMBIA INSTITUTION FOR THE DEAF AND DUMB.							
Current expenses, Columbia Institution for the Deaf and Dumb.	For the support of the institution, in addition to the amount already appropriated, $3,000, being a deficiency for the fiscal year 1878	.... Appropriated	R. S. 19	949 347	4859, 4869 1	....	3,000 00	48,000 00
Buildings, Columbia Institution for the Deaf and Dumb.	For the fitting up and furnishing of the buildings of the institution, including necessary repairs on the said buildings, $2,500, being a deficiency for the fiscal year 1878	Appropriated	19	347	1	....	2,500 00	69,524 62
	NOTE.—The appropriation of $69,524 62 for the fiscal year 1878, was for the erection and fitting up, &c.							
Improvement and care of grounds, Columbia Institution for the Deaf and Dumb.	For the enclosure, improvement, and care of the grounds of the institution	Appropriated Submitted ...	16	500	1	....	10,000 00	
	NOTE.—For explanation of the estimates for Columbia Institution for the Deaf and Dumb, see Appendix, marked "M."							
	PUBLIC LANDS.							
Surveying public lands in Arizona.	Amount due Solomon W. Foreman, deputy surveyor, for surveys executed under contract of August 1, 1871, being a deficiency for the fiscal year 1872	March 3, 1871	16	502	1	....	75 11	20,000 00
	Amount due Theodore F. White, deputy surveyor, for surveys executed under contract of May 13, 1873, being a deficiency for the fiscal year 1874	March 3, 1873	17	516	1	....	45 94	20,000 00
	Amount due Theodore F. White, deputy surveyor, for surveys executed under contract of September 23, 1874, being a deficiency for the fiscal year 1875	June 23, 1874	18	212	1	....	81 84	20,000 00
	Amounts due Theodore F. White, deputy surveyor, for surveys executed under contracts, as follows: June 25, 1875, $67 53; December 6, 1875, $213 27; being a deficiency for the fiscal year 1876	March 3, 1875	18	383	1	....	280 80	20,000 00
Surveying public lands in California.	Amount due Joseph J. Cloud, deputy surveyor, for surveys executed under contract of April 6, 1871, being a deficiency for the fiscal year 1871	July 15, 1870	16	304	1	....	9 39	50,000 00
	Amounts due for surveys executed under contracts, as follows:							
	J. R. Glover, deputy surveyor, under contract of September 16, 1875	March 3, 1875	18	383	1	$388 21		
	F. T. Perris, deputy surveyor, under contract of January 31, 1876	do				268 66		
	John Gilchrist, deputy surveyor, under contract of January 21, 1876	do				535 94		
	John A. Benson, deputy surveyor, under contract of December 13, 1875	do				491 60		
	D. D. Brown, deputy surveyor, under contract of July 19, 1875	do				282 64		
	S. W. Brunt, deputy surveyor, under contract of June 10, 1875	do				2,205 11		
	Wm. Minto, deputy surveyor, under contract of June 26, 1875	do				2,266 85		
	Being a deficiency for the fiscal year 1876.						6,439 01	70,000 00

Estimates of appropriations required by the various Departments, &c.—Continued.

General object. (Title of appropriation.)	Detailed objects of expenditure, and explanations.	Date of acts, resolutions, or treaties, authorizing or providing for the expenditures.	References to Statutes at Large, or to Revised Statutes. Vol. or R. S.	Page	Sec.	Estimated amount which will be required for each detailed object of expenditure.	Total amount to be appropriated under each head of appropriation.	Amount appropriated for the fiscal year for which the appropriation is required.
	PUBLIC LANDS—Continued.							
Surveying public lands in Florida.	Amount due John A. Henderson, deputy surveyor, for surveys executed under contract of December 23, 1875, being a deficiency for the fiscal year 1876	March 3, 1875	18	383	1	....	$302 63	$10,000 00
Surveying public lands in Louisiana.	Amount due S. P. Henry, deputy surveyer, for surveys executed under contract of January 21, 1875, being a deficiency for the fiscal year 1875	June 23, 1874	18	212	1	....	750 00	15,000 00
	NOTE.—It is estimated that the surveys under the above contract will amount to $750. An unexpended balance of $417 21 of the appropriation, to which it is properly chargeable, was carried to surplus fund June 30, 1877, but being insufficient to defray the estimated cost of the surveys under the above contract, the amount is submitted as a deficiency.							
	Amount due Pierre A. Thibodeaux, deputy surveyor, for surveys executed under contract of July 17, 1875, being a deficiency for the fiscal year 1876	March 3, 1875	18	383	1	....	57 50	15,000 00
Surveying public lands in Oregon.	Amount due Wm. E. Smith, deputy surveyor, for surveys executed under contract of May 4, 1871, being a deficiency for the fiscal year 1872	March 3, 1871	16	502	1	....	70 55	50,000 00
	Amount due S. Corwin and J. C. Handley, deputy surveyors, for surveys executed under contract of February 26, 1873, being a deficiency for the fiscal year 1873	June 10, 1872	17	358	1	....	263 52	70,000 00
	Amounts due for surveys executed under contracts, as follows:							
	Jasper W. Wilkins, deputy surveyor, under contract of June 21, 1873	March 3, 1873	17	516	1	$65 86		
	Jason Owen, deputy surveyor, under contract of July 1, 1873	......do......	......	......	......	55 83		
	John D. Crawford, deputy surveyor, under contrat of July 9, 1873	......do......	......	......	......	181 54		
	Wm. H. Byars, deputy surveyor, under contract of July 14, 1873	......do......	......	......	......	12 13		

	L. F. Bannon and N. O. Walden, deputy surveyors, under contract of July 15, 1873	do.				80 11		
	Being a deficiency for the fiscal year 1874.						395 47	70,000 00
	Amount due J. H. Evans and J. G. Gray, deputy surveyors, for surveys executed under contract of July 6, 1874, being a deficiency for the fiscal year 1875	June 23, 1874	18	213	1		15 12	60,000 00
	NOTE.—The foregoing estimates for surveying public lands in Arizona, California, Florida, Louisiana, and Oregon, are submitted in order to liquidate balances due to the deputy surveyors for surveys executed under their respective contracts entered into with the respective surveyors-general of the United States and Territories. The deficiencies were caused by said surveyors-general under-estimating the cost of the work embraced in the contracts, but as the surveys have been approved and are available to the Government in the disposal of the lands thus surveyed, the respective sums are submitted.							
Surveying public lands...	Amounts due for surveys executed under contracts, as follows:							
	New Mexico: Wm. H. McBroom, deputy surveyor, under contract of September 27, 1876	July 31, 1876	19	190	1	104 45		
	Arizona: Theodore F. White, deputy surveyor, under contract of December 7, 1876	do.				113 54		
	Nevada: G. W. Garside, deputy surveyor, under contract of November 11, 1876	do.				256 31		
	Being a deficiency for the fiscal year 1877.						474 30	300,000 00
	NOTE.—The foregoing estimates are for deficiencies arising under limited contracts, the amount submitted being in excess of the respective contracts, caused by the respective surveyors-general under-estimating the cost of the work. The lands surveyed were included in the contracts, and the surveys having been approved and made available in the disposal of the lands so surveyed, the respective sums are submitted.							
Surveying private land claims in New Mexico.	Amount due Sawyer & McBroom, deputy surveyors, for surveys executed under contract of April 15, 1876, being a deficiency for the fiscal year 1876	March 3, 1875	18	384	1		472 83	10,000 00
	NOTE.—Sawyer & McBroom's contract was limited to the sum of $9,900. The surveys executed by them under their contract amounted to $10,372 83, exceeding the limit by $472 83. The private land claims surveyed were authorized by their contract, and the surveys having been approved, this item is submitted.							
Survey of boundaries of Indian reservations.	California: Amount due John A. Benson, deputy surveyor, for surveys executed under contract of November 14, 1876	Submitted					913 46	
	NOTE.—The above contract was for surveying the out-boundaries of the Round-Valley Indian reservation in California, for which no appropriation is applicable. It was necessary, however, to have the boundaries of this Indian reservation surveyed, in order to make the adjacent public lands available, and to keep white settlers from intruding on the reservation.							

Estimates of appropriations required by the various Departments, &c.—Continued.

General object. (Title of appropriation.)	Detailed objects of expenditure, and explanations.	Date of acts, resolutions, or treaties, authorizing or providing for the expenditures.	References to Statutes at Large, or to Revised Statutes. Vol. or R. S.	Page.	Sec.	Estimated amount which will be required for each detailed object of expenditure.	Total amount to be appropriated under each head of appropriation.	Amount appropriated for the fiscal year for which the appropriation is required.
	PUBLIC LANDS—Continued.							
Salaries, office of surveyor-general of Arizona.	Clerks in his office, being a deficiency for the fiscal year 1878...	March 3, 1877	19	315	1	....	$2,500 00	$3,000 00
Contingent expenses, office of surveyor-general of Arizona.	Rent of office, fuel, books, stationery, and other necessaries, being a deficiency for the fiscal year 1878.....................	March 3, 1877	19	349	1	....	1,000 00	1,500 00
Salaries, office of surveyor-general of Colorado.	Clerks in his office, being a deficiency for the fiscal year 1878...	March 3, 1877	19	315	1	....	2,500 00	3,000 00
Contingent expenses, office of surveyor-general of Colorado.	Rent of office, fuel, books, stationery, and other necessaries, being a deficiency for the fiscal year 1878.....................	March 3, 1877	19	349	1	....	1,000 00	1,500 00
	NOTE.—The above estimated deficiencies arise from the fact that Congress has imposed upon the United States surveyors-general the duty of examining and reporting upon the validity of title to private land claims in Arizona and Colorado—the estimated amount for clerk-hire being for the pay of a competent clerk in each office, versed in the English and Spanish languages, to act as translators; and the deficiencies in contingent expenses arise also under the duties of the United States surveyors-general, in examining and adjudicating private land claims. These estimates are necessary for the public service, unless Congress should, as recommended by the Commissioner of the General Land Office, devolve said duties upon a board of commissioners to be authorized to act for that purpose.							
Salaries, office of surveyor-general of New Mexico.	Salaries of clerks in his office, being a deficiency for the fiscal year 1878..	March 3, 1877	19	315	1	....	3,000 00	5,000 00
	NOTE.—The above estimate is submitted for salaries of two draughtsmen and two copyists, for six months, in the office of the surveyor-general of New Mexico. The sum of $33,500 having been apportioned to New Mexico for the survey of private land							

	claims from the appropriation of $300,000, of March 3, 1877, for the survey of public and private lands, the appropriation of $5,000, of March 3, 1877, for salaries of clerks in said office, will not be sufficient to pay the salaries of the clerks necessary to perform the work arising under the above large apportionment, and keep up the current business of the office. The services of the present force of clerks will be required to perform the work arising under the survey of public lands.							
Contingent expenses, office of surveyor-general of Idaho.	To pay L. F. Cartee, surveyor-general of Idaho, for expenses incurred in investigating certain surveys, under instructions from the General Land Office, dated November 19, 1868, being a deficiency for the fiscal year 1871, and prior years	July 15, 1870	16	293	1	....	299 94	2,000 00
	NOTE.—The sum of $299 94 is submitted to refund the expenses incurred in investigating certain surveys in the field, under instructions from the Commissioner of the General Land Office, dated November 19, 1868, the contingent fund of the surveyor-general's office not admitting at the time of liquidating the amount due him. This estimate was formerly submitted for appropriation, but not eventuating in any provision for the purpose, and the claim being a just one, and of long standing, is herewith submitted again, with recommendation that it receive favorable action.							
Contingent expenses, office of surveyor-general of Nevada.	Salary of messenger in surveyor-general's office, from July 1, 1876, to June 30, 1877	July 31, 1876	19	122	1	$480 00		
	Amount due A. L. Bancroft & Co., for stationery, being deficiencies for the fiscal year 1877	......do......	.....	.....	....	68 75	548 75	1,500 00
	NOTE.—The foregoing deficiency in the salary of messenger in the surveyor-general's office arises from the fact that the appropriation of $1,500 for the fiscal year ending June 30, 1877, was insufficient to pay the salary of the messenger, and defray the other necessary incidental expenses of the office. The messenger was retained in the service by the surveyor-general during the period specified, and, being entitled to his pay for said services, the above estimate is submitted. The estimate of $68 75 is for stationery purchased by the surveyor-general during the fiscal year ending June 30, 1877. The appropriation for that year having been exhausted, the amount is submitted for appropriation.							
	MISCELLANEOUS.							
Geological survey of the Territories.	Rent of building and office-furniture	Submitted ...	.....	.....	....	....	4,000 00	
	Preparation of atlas of the Black Hills	Appropriated Submitted ...	19	120	1	3,000 00		
	Engraving and printing of geological plates to accompany the Black Hills report	......do......	.....	.....	....	1,840 00	4,840 00	14,000 00
	NOTE.—For explanation of these estimates, see Appendix, marked "N."							

Estimates of appropriations required by the various Departments, &c.—Continued.

General object. (Title of appropriation.)	Detailed objects of expenditure, and explanations.	Date of acts, resolutions, or treaties, authorizing or providing for the expenditures.	References to Statutes at Large, or to Revised Statutes. Vol. or R. S.	Page.	Sec.	Estimated amount which will be required for each detailed object of expenditure.	Total amount to be appropriated under each head of appropriation.	Amount appropriated for the fiscal year for which the appropriation is required.
	MISCELLANEOUS—Continued.							
Lighting Capitol and grounds.	For gas consumed for the month of June, 1877, being a deficiency for the service of the fiscal year 1877	Appropriated.	19	114	1	....	$1,048 95	$32,000 00
	INDIAN AFFAIRS.							
Pay of superintendents and agents.	Amount due Silas F. Kendrick for services rendered as Indian agent for Pueblo Indians, in New Mexico, during the second quarter 1861, being a deficiency for the fiscal year 1873, and prior years	May 29, 1872	17	165	1	....	271 25	121,100 00
Contingencies, Indian department.	Amount due the Missouri River, Fort Scott, and Gulf Railroad Company for transporting, in 1871, certain Wyandotte and Shawnee Indians from Kansas City to Baxter Springs, en route to the Indian Territory, being a deficiency for the fiscal year 1873, and prior years	May 29, 1872	17	166	1	$600 60		
	Amount due Joseph D. Gurnoe for services rendered as clerk at the La Pointe agency, Wisconsin, in June, 1873, being a deficiency for the fiscal year 1873, and prior years	.....do......	.....	....	.....	13 50		
	Amount due Joseph J. Woods for services rendered from October 29 to November 6, 1871, at $8 per day, as commissioner to examine Cherokee country west of ninety-sixth meridian, nine days' service, being a deficiency for the fiscal year 1873, and prior years	.....do......	.....	....	.....	72 00	686 10	50,000 00
Fulfilling treaty with Shawnees.	Amount due the Shawnee Indians for arrears of annuities, under the third article treaty of May 10, 1854, being a part of the balance due the said Shawnees for lands ceded to the United States under the first article of said treaty, being a deficiency for the fiscal year 1873, and prior years	May 29, 1872	17	181	1	....	10,406 39	5,000 00
Colonizing and supporting the Wichitas and other affiliated bands.	Amount due the Kansas Pacific Railroad Company for amount of charges advanced the Saint Louis, Kansas City, and Northern Railway Company, on account of transportation of Indian supplies in 1873, being a deficiency for the fiscal year 1873, and prior years	May 29, 1872	17	184	1	....	21 30	50,000 00

Incidental expenses, Indian service in Dakota.	This amount to reimburse Charles P. Birkett, late United States Indian agent, for amount expended by him for the benefit of the Indians located at the Ponca agency, Dakota Territory, during the fiscal year ending June 30, 1873, as shown by the books of the Indian Office, being a deficiency for the fiscal year 1873, and prior years	May 29, 1872	17	187	1		1,097 22	20,000 00
Incidental expenses, Indian service in New Mexico.	Amount due J. Rinehart for services rendered as acting agent at the Cimarron agency, New Mexico, in May, 1872, being a deficiency for the fiscal year 1873, and prior years	May 29, 1872	17	187	1	56 66		
	Amount due Ignacio Archetola for salt furnished in June, 1873, for the Abiquiu agency, New Mexico, being a deficiency for the fiscal year 1873, and prior years	do.				14 00		
	Amount due the Maxwell Land-Grant and Railway Company for rent of office for use of the agent at Cimarron agency, New Mexico, from Septemper 30, 1872, to March 30, 1873, being a deficiency for the fiscal year 1873, and prior years	do.				85 00		
	Amount due José Maria Archutella for services rendered in March, 1873, at the same agency, being a deficiency for the fiscal year 1873, and prior years	do.				17 00		
	Amount due John W. Miller for services rendered as blacksmith at the Navajo agency, New Mexico, during the second quarter 1873, being a deficiency for the fiscal year 1873, and prior years	do.				210 00		
	Amount due Louis Clark for 3,772¼ pounds corn, furnished in December, 1872, for the Indian service in New Mexico, being a deficiency for the fiscal year 1873, and prior years	do.				75 45		
	Amount due Rogue Sanches for fresh beef and mutton furnished in April, 1873, for the Abiquiu agency, New Mexico, being a deficiency for the fiscal year 1873, and prior years	do.				78 50		
	Amount due J. Rinehart for services rendered as acting agent, in 1873, at the Cimarron agency, New Mexico, being a deficiency for the fiscal year 1873, and prior years	do.				400 00		
	This amount to pay indebtedness incurred on account of the service at the Mescalero Apache agency, in second quarter 1873, viz: Pay of one laborer, $90, and one blacksmith, $82 50, as per statement of S. B. Bushnell, agent in charge, on file in the Indian Office, being a deficiency for the fiscal year 1873, and prior years	do.				172 50		
	Amount due Fellipie Madrille for beef, wheat, and flour, furnished in second quarter 1873, for the Abiquiu agency, New Mexico, being a deficiency for fiscal year 1873, and prior years	do.				164 25		
	Amount due Jacob Krummeck for subsistence furnished in March and April, 1873, for the service at the same agency, being a deficiency for the fiscal year 1873, and prior years	do.				103 25		
	Amount due Sp igelberg Bros. for provisions furnished in April, 1873, for the same agency, being a deficiency for the fiscal year 1873, and prior years	do.				43 25		
	Amount due Speigelberg Bros. for blankets, &c., furnished in January and February, 1873, for Indians visiting the New Mexico superintendency, being a deficiency for the fiscal year 1873, and prior years	do.				29 00		

Estimates of appropriations required by the various Departments, &c.—Continued.

General object. (Title of appropriation.)	Detailed objects of expenditure, and explanations.	Date of acts, resolutions, or treaties, authorizing or providing for the expenditures.	References to Statutes at Large, or to Revised Statutes. Vol. or R. S.	Page.	Sec.	Estimated amount which will be required for each detailed object of expenditure.	Total amount to be appropriated under each head of appropriation.	Amount appropriated for the fiscal year for which the appropriation is required.
	INDIAN AFFAIRS—Continued.							
Incidental expenses, Indian service in New Mexico—Continued.	Amount due Tom Navajo for services rendered as herder at the Navajo agency, in June, 1873, being a deficiency for the fiscal year 1873, and prior years	May 29, 1872	17	187	1	$10 00		
	Amount due W. W. Owens for amount advanced to Indian employés of the Navajo agency for herding, during the first and second quarters, 1873, being a deficiency for the fiscal year 1873, and prior years	do				388 00		
	Amount due Lionel Ayers for amount advanced in goods and money to Indian employés at the Navajo agency, New Mexico, during the first and second quarters, 1873, being a deficiency for the fiscal year 1873, and prior years	do				536 00		
	Amount due Serfine Chacon for repairing an ambulance belonging to the Abiquin agency, New Mexico, in February, 1873, being a deficiency for the fiscal year 1873, and prior years	do				12 00		
	Amount due John B. McCullough for postage-stamps furnished the Cimarron agency, New Mexico, in May and June, 1873, being a deficiency for the fiscal year 1873, and prior years	do				5 00	$2,399 86	$50,000 00
Incidental expenses, Indian service in Oregon.	Amount due William P. Harris for services rendered as blacksmith at the Klamath agency, Oregon, in the fourth quarter, 1871, as per voucher on file in the Indian Office, being a deficiency for the fiscal year 1873 and prior years	May 29, 1872	17	187	1	269 00		
	Amount due George W. Collins for services rendered as superintendent of farming at Alsea sub-agency, Oregon, in second quarter, 1873, being a deficiency for the fiscal year 1873, and prior years	do				66 66		
	Amount due Allen & Lewis for supplies furnished the Siletz agency, Oregon, in September, 1872, being a deficiency for the fiscal year 1873, and prior years	do				79 70		
	Amount due Wm. T. Newcomb for services rendered at Siletz agency, Oregon, from April 18, 1860, to June 30, 1861, being a deficiency for 1873, and prior years	do				1,862 37		
	Amount due Frank Hill for transportation furnished for the service at the Siletz agency, Oregon, in December, 1872, being a deficiency for the fiscal year 1873, and prior years	do				15 64		

	Amount due S. R. Baxter for shoeing public animals belonging to the Siletz agency, Oregon, in November, 1872, being a deficiency for the fiscal year 1873, and prior years	....do				13 00		
Incidental expenses, Indian service in Utah.	Amount due George Elliott for services rendered as brick-maker at the Siletz agency, Oregon, in May, 1872, being a deficiency for the fiscal year 1873, and prior years	....do				25 29	2,331 56	40,000 00
	Amount due Pardon Dodds for herding twenty-eight head of cattle at the Uintah Valley agency, Utah, from December 1, 1872, to June 30, 1872, at $50 per month, seven months, being a deficiency for the fiscal year 1873, and prior years	May 29, 1872	17	187	1		350 00	25,000 00
Fulfilling treaty with Pawnees.	Amount due Union Pacific Railroad Company for transporting annuity goods and supplies to the Pawnee agency during the fiscal year ending June 30, 1874, being a deficiency for the fiscal year 1874	Feb. 14, 1873	17	451	1		247 77	55,680 00
Fulfilling treaty with Pottawatomies.	This amount for deficiency of money annuities, for the fiscal year ending June 30, 1874, due the Prairie band of Pottawatomies, under treaty stipulations, being a deficiency for the fiscal year 1874	Feb. 14, 1873	17	451	1		4,341 30	42,645 14
Fulfilling treaty with Shoshones and Bannacks.	Amount due Union Pacific Railroad Company for transporting annuity goods and supplies to the Shoshones and Bannacks and other bands of Idaho and Southeastern Oregon, during the fiscal year ending June 30, 1874, being a deficiency for the fiscal year 1874	Feb. 14, 1873	17	455	1		2,710 96	85,911 00
Fulfilling treaty with Sioux of different tribes, including Santee Sioux of Nebraska.	Amount due Union Pacific Railroad Company for transporting annuity goods and supplies to the Sioux Indians during the fiscal year ending June 30, 1874, being a deficiency for the fiscal year 1874	Feb. 14, 1873	17	453	1		4,238 61	1,871,800 00
Fulfilling treaty with Tabequache, Muache, Capote, Weminuche, Yampa, Grand River, and Uintah bands of Utes.	Amount due Union Pacific Railroad Compony for transporting annuity goods and supplies purchased for the service at the White River agency, Colorado, during the fiscal year ending June 30, 1874, being a deficiency for the fiscal year 1874	Feb. 14, 1873	17	457	1		947 97	78,220 00
Incidental expenses, Indian service in Arizona.	Amount due Union Pacific Railroad Company for transportation furnished Indian agents in March and June, 1874, being a deficiency for the fiscal year 1874	Feb. 14, 1873	17	459	1	158 55		
	Amount due Union Pacific Railroad Company for transporting annuity goods and supplies purchased for Indians located in Arizona, during the fiscal year ending June 30, 1874, being a deficiency for the fiscal year 1874	....do				26 10		
	Amount due Harrington & Gilbert for running 1,173 feet of tunnel through Mesa, on the Colorado River Indian reservation, Arizona Territory, in June, 1874, under contract, being a deficiency for the fiscal year 1874	....do				77 77		

Estimates of appropriations required by the various Departments, &c.—Continued.

General object. (Title of appropriation.)	Detailed objects of expenditure, and explanations.	Date of acts, resolutions, or treaties, authorizing or providing for the expenditures.	References to Statutes at Large, or to Revised Statutes. Vol. or R. S.	Page.	Sec.	Estimated amount which will be required for each detailed object of expenditure.	Total amount to be appropriated under each head of appropriation.	Amount appropriated for the fiscal year for which the appropriation is required.
	INDIAN AFFAIRS—Continued.							
Incidental expenses, Indian service in Arizona—Continued.	Amount due W. W. Williams for rent of office, storeroom, and stable for Papago agency, from April 1 to June 30, 1874, being a deficiency for the fiscal year 1874	Feb. 14, 1873	17	459	1	$150 00		
	Amount due Mary Maximus for service as teacher at the Papago agency, from April 1 to June 30, 1874, being a deficiency for the fiscal year 1874	....do				150 00		
	Amount due Mary Francisco for service rendered as teacher at Papago agency, from February 2 to March 31, and from April 1 to June 30, 1874, being a deficiency for the fiscal year 1874	....do				245 12		
	Amount due James H. Toole for services rendered in appraising improvements on certain lands proposed for Papago Indian reservation, from March 24 to 25, inclusive, 1874, being a deficiency for the fiscal year 1874	....do				30 00		
	Amount due Mary of Jesus for services as teacher at the Papago agency, from February 2 to March 31, and from April 1 to June 30, 1874, being a deficiency for the fiscal year 1874	....do				245 12		
	Amount due Euphrasia St. Joseph for services as teacher at the Papago agency, from April 1 to June 30, 1874, being a deficiency for the fiscal year 1874	....do				150 00		
	Amount due Soloman Warner for services rendered in appraising improvements on certain lands proposed for Papago Indian reservation, from March 20 to 25, inclusive, 1874, being a deficiency for the fiscal year 1874	....do				30 00		
	Amount due H. W. Livingston for services rendered as laborer at the Colorado River reservation, Arizona, during the first and second quarters, 1874, being a deficiency for the fiscal year 1874	....do				331 00		
	Amount due James Brown for services rendered as laborer on the irrigating canal at Colorado River reservation, Arizona, in June, 1874, being a deficiency for the fiscal year 1874	....do				54 00	$1,647 66	$75,000 00
Incidental expenses, Indian service in California.	Amount due Hop-Kee & Co. for shoes furnished under contract for the Tule River agency, California, in October, 1873, being a deficiency for the fiscal year 1874	Feb. 14, 1873	17	459	1	237 36		

	Amount due Mission and Pacific Woollen Mills for clothing furnished under contract for the same agency, in October, 1873, being a deficiency for the fiscal year 1874	....do....	....	....	....	499 25		
	Amount due Hooker & Co. for hardware furnished under contract for the same agency, in October, 1873, being a deficiency for the fiscal year 1874	....do....	....	....	....	413 93		
	Amount due Murphy, Grant & Co. for goods, &c., furnished under contract for the same agency, in October, 1873, being a deficiency for the fiscal year 1874	....do....	....	....	....	345 37		
	Amount due Fordham & Jennings for subsistence supplies furnished under contract for the same agency, in October, 1873, being a deficiency for the fiscal year 1874	....do....	....	....	....	266 59		
	Amount due Lindenburger & Burke for hats furnished under contract for the same agency, in October, 1873, being a deficiency for the fiscal year 1874	....do....	....	....	....	35 53		
	Amount due S. Greenbaum for transporting annuity goods and supplies to Hoopa Valley reservation, California, under contract, during the fiscal year ending June 30, 1874, being a deficiency for the fiscal year 1874	....do....	....	....	....	794 52		
	Amount due A. Brizzard for supplies furnished the Hoopa Valley reservation, California, in March, April, May, and June, 1874, being a deficiency for the fiscal year 1874	....do....	....	....	....	1,999 71		
	Amount due Marcus C. Hawley & Co. for hardware furnished the Hoopa Valley agency, California, during the fiscal year ending June 30, 1874, being a deficiency for the fiscal year 1874	....do....	....	....	....	121 72	4,713 98	85,000 00
Incidental expenses, Indian service in Dakota.	This amount, to meet liabilities contracted on account of the service at the Grand River agency, Dakota, during the first and second quarters, 1874, on account of supplies furnished, as per vouchers on file in the Indian Office, being a deficiency for the fiscal year 1874	Feb. 14, 1873	17	460	1	509 79		
	Amount due Northern Pacific Railroad Company for balance due on account of transportation of supplies to Fort Berthold, in December, 1873, being a deficiency for the fiscal year 1874	....do....	....	....	....	704 14	1,213 93	20,000 00
Incidental expenses, Indian service in Idaho.	This amount, to be applied in the payment of indebtedness incurred on account of the service at the Fort Hall agency, Idaho, during the first and second quarters, 1874, as per statement of Henry Reed, late agent, on file in the Indian Office, being a deficiency for the fiscal year 1874	Feb. 14, 1873	17	460	1	....	5,703 27	20,000 00
Incidental expenses, Indian service in Nevada.	This amount, to be applied in payment of liabilities contracted on account of the service at Walker River and Pyramid Lake agency, Nevada, during the second quarter, 1874, being for pay of employés, subsistence, seeds, travelling expenses of the agent, &c., as per statement of Agent C. A. Bateman, on file in the Indian Office, being a deficiency for the fiscal year 1874.	Feb. 14, 1873	17	460	1	....	3,585 06	25,000 00
Incidental expenses, Indian service in New Mexico.	**Amount due J. B. Lamay for the hire of an ambulance to Agent W. D. Crothers, in April, 1874, being a deficiency for the fiscal year 1874**	Feb. 14, 1873	17	460	1	21 00		

Estimates of appropriations required by the various Departments, &c.—Continued.

General object. (Title of appropriation.)	Detailed objects of expenditure, and explanations.	Date of acts, resolutions, or treaties, authorizing or providing for the expenditures.	References to Statutes at Large, or to Revised Statutes. Vol. or R. S.	Page.	Sec.	Estimated amount which will be required for each detailed object of expenditure.	Total amount to be appropriated under each head of appropriation.	Amount appropriated for the fiscal year for which the appropriation is required.
	INDIAN AFFAIRS—Continued.							
Incidental expenses, Indian service in New Mexico—Continued.	Amount due Charles Robbins for services rendered as farmer, at the Abiquiu agency, New Mexico, in March and April, 1874, being a deficiency for the fiscal year 1874	Feb. 14, 1873	17	460	1	$136 67		
	Amount due Charles Carter for services as teamster at the Pueblo agency, from April 1 to June 30, 1874, being a deficiency for the fiscal year 1874	....do....	....	....	....	120 00		
	Amount due Agiela, Ute chief, for services rendered as guide, from August 3 to October 25, 1873, at Cimarron agency, New Mexico, being a deficiency for the fiscal year 1874	....do....	....	....	....	50 00		
	Amount due Seligman Brothers & Co. for timber, &c., furnished in second quarter, 1874, for the New Mexico superintendency, being a deficiency for the fiscal year 1874	....do....	....	....	....	20 75		
	Amount due O. C. Crothers for services rendered in March, 1874, at the Abiquiu agency, New Mexico, being a deficiency for the fiscal year 1874	....do....	....	....	....	77 41		
	Amount due A. Cayetana Garcia for subsistence supplies furnished during the second quarter, 1874, for the New Mexico superintendency, being a deficiency for the fiscal year 1874	....do....	....	....	....	69 05		
	Amount due Joseph J. Herrera for services rendered in June, 1874, at the Abequiu agency, New Mexico, being a deficiency for the fiscal year 1874	....do....	....	....	....	102 33		
	Amount due Probst & Kirchner for 207½ pounds of beef furnished in June, 1874, for Indians at the same agency, being a deficiency for the fiscal year 1874	....do....	....	....	....	16 60		
	Amount due M. A. Breeden for rent of post-office box to the superintendent of Indian affairs for New Mexico, in June, 1874, being a deficiency for the fiscal year 1874	....do....	....	....	....	3 90		
	Amount due Maxwell Land-Grant and Railway Company for rent of building for the use of the agent at Cimarron agency, New Mexico, in January, 1874, being a deficiency for the fiscal year 1874	....do....	....	....	....	12 00		
	Amount due William White for expenses incurred in travelling, in April, 1874, on account of the Indian service in New Mexico, being a deficiency for the fiscal year 1874	....do....	....	....	....	32 00		

Amount due William White for services rendered as acting agent at the Cimarron agency, New Mexico, in April, 1874, being a deficiency for the fiscal year 1874	....do......	....	....	....	147 30	
Amount due T. D. Burns for rent of buildings for the service at the Abiquiu agency, New Mexico, in September, 1873, being a deficiency for the fiscal year 1874	....do......	....	....	....	45 10	
Amount due Bernardo Sanchez for beef and mutton furnished in August, 1873, for the service at the same agency, being a deficiency for the fiscal year 1874	....do......	....	....	....	104 00	
Amount due A. G. Irvine for hardware furnished in June, 1874, for the service in New Mexico, being a deficiency for the fiscal year 1874	....do......	....	....	....	6 90	
Amount due Ilfeld & Co. for supplies furnished the superintendent of Indian affairs for New Mexico in April and May, 1874, being a deficiency for the fiscal year 1874	....do......	....	....	....	19 35	
Amount due Z. Staab and Alexander Gusdorf for 2,900 pounds of flour furnished under contract in February, 1874, for the Abiquiu agency, New Mexico, being a deficiency for fiscal year 1874.	....do......	....	....	....	123 25	
Amount due Z. Staab and Alexander Gusdorf for 12,000 pounds of flour furnished under contract in April and May, 1874, for same agency, being a deficiency for the fiscal year 1874	....do......	....	....	....	510 00	
Amount due W. A. Crocker for services rendered in June, 1874, as clerk at the Cimarron agency, New Mexico, being a deficiency for the fiscal year 1874	....do......	....	....	....	40 00	
Amount due Julien Lopes for 25 cords of wood furnished in November, 1873, for the Mescalero Apache agency, New Mexico, being a deficiency for the fiscal year 1874	....do......	....	....	....	75 00	
Amount due Charles H. Coleman for shoeing public animals in December, 1873, and January and February, 1874, at the same agency, being a deficiency for the fiscal year 1874	....do......	....	....	....	56 00	
Amount due Z. Staab & Co. for supplies furnished in April, 1874, for the Abiquiu agency, New Mexico, being a deficiency for the fiscal year 1874	....do......	....	....	....	155 00	
Amount due Pedro Y. Jaramillo for beef and wheat furnished in May, 1874, for the same agency, being a deficiency for the fiscal year 1874	....do......	....	....	....	194 00	
Amount due Charles Roselle for services rendered as teamster in March, 1874, at the same agency, being a deficiency for the fiscal year 1874	....do......	....	....	....	8 88	
Amount due William A. Crocker for rent of buildings from January 20 to April 20, 1874, for the service in New Mexico, being a deficiency for the fiscal year 1874	....do......	....	....	....	54 00	
Amount due William A. Crocker for services rendered at the Cimarron agency, New Mexico, from February 1 to April 20, 1874, being a deficiency for the fiscal year 1874	....do......	....	....	....	166 66	
Amount due Charles H. McVeagh for services as butcher at the Mescalero Apache agency from April 1 to April 7, 1874, being a deficiency for the fiscal year 1874	....do......	....	....	....	10 50	
Amount due J. W. Southwick for services rendered in May, 1874, at the Abiquiu agency, New Mexico, being a deficiency for the fiscal year 1874	....do......	....	....	....	46 67	

Estimates of appropriations required by the various Departments, &c.—Continued.

General object. (Title of appropriation.)	Detailed objects of expenditure, and explanations.	Date of acts, resolutions, or treaties, authorizing or providing for the expenditures.	References to Statutes at Large, or to Revised Statutes. Vol. or R. S.	Page.	Sec.	Estimated amount which will be required for each detailed object of expenditure.	Total amount to be appropriated under each head of appropriation.	Amount appropriated for the fiscal year for which the appropriation is required.
	INDIAN AFFAIRS—Continued.							
Incidental expenses, Indian service in New Mexico—Continued.	Amount due Don Vicente (Indian) for services rendered in May, 1874, at the same agency, being a deficiency for the fiscal year 1874	Feb. 14, 1873	17	460	1	$5 00		
	Amount due Chandler Robbins for travelling expenses in May, 1874, in connection with the service at same agency, being a deficiency for the fiscal year 1874	......do..	....	......	.....	47 00		
	Amount due Chiome (Indian) for services rendered in June, 1874, at the same agency, being a deficiency for the fiscal year 1874	.....do.......	....	......	.....	7 20		
	Amount due Fernandez Montana for 256 pounds of hay, furnished in May, 1874, for same agency, being a deficiency for the fiscal year 1874	.....do.......	.....	......	....	7 50		
	Amount due Z. Staab & Co. for articles of stationery furnished in August and September, 1873, for the Southern Apache agency, New Mexico, being a deficiency for the fiscal year 1874	.....do.......	......	.....	......	32 50		
	Amount due M. A. Breeden for articles of stationery furnished in May, 1874, for the Mescalero Apache agency, New Mexico, being a deficiency for the fiscal year 1874	.....do.......	.....	.....	......	17 20		
	Amount due R. H. Longwell for medicines, &c., furnished in November and December, 1873, for the Cimarron agency, New Mexico, being a deficiency for the fiscal year 1874	.....do.......	.....	....	......	16 70		
	Amount due Sixto Chavez for 1,500 pounds of corn furnished for the service at the Abiquiu agency in May, 1874, being a deficiency for the fiscal year 1874	......do.......	.....	.....	.....	105 00		
	Amount due Pedro Y. Jaramillo for 6,120 pounds of wheat furnished the same agency in June, 1874, being a deficiency for the fiscal year 1874	......do.	.....	.....	......	306 00		
	Amount due M. Traner for supplies furnished in second quarter 1874, for the Cimarron agency, New Mexico, being a deficiency for the fiscal year 1874	......do.......	....	.....	.....	179 69		
	Amount due Valentine Herbert for services rendered as teamster in May and June, 1874, at the New Mexico superintendency, being a deficiency for the fiscal year 1874	.....do.......	....	....	.....	190 00		

Amount due Frederick C. Bishop for services rendered as clerk at the office of the superintendent of Indian affairs for New Mexico in June, 1874, being a deficiency for the fiscal year 1874	....do.......	....	....	....	75 00		
Amount due S. C. Dudley for services rendered as clerk for the same officer in May and June, 1874, being a deficiency for the fiscal year 1874	....do.......	....	....	....	250 00		
Amount due Speigelberg Brothers for one sack of flour furnished in February, 1874, to Indians in New Mexico, being a deficiency for the fiscal year 1874	....do.......	....	....	....	5 00		
Amount due George Chase for shoeing animals belonging to the Navajo agency, New Mexico, in October, 1873, and May and June, 1874, being a deficiency for the fiscal year 1874	....do.......	....	....	....	70 25		
Amount due William Bolander for repairing harness, &c., in April and June, 1874, for the superintendent of Indian affairs for New Mexico, being a deficiency for the fiscal year 1874	....do.......	....	....	....	14 45		
Amount due J. B. McCullough for rent of post-office box to the agent at the Cimarron agency, New Mexico, in April, 1874, being a deficiency for the fiscal year 1874	....do.......	....	....	....	2 00		
Amount due E. Andrews for articles of stationery furnished in April and May, 1874, for the office of the superintendent of Indian affairs for New Mexico, being a deficiency for the fiscal year 1874	....do.......	....	....	....	20 25		
Amount due J. L. Gould for services rendered as special agent in November, 1874, at the Navajo agency, New Mexico, and for travelling expenses in returning to his home, being a deficiency for the fiscal year 1874	....do.......	....	....	....	322 00		
Amount due Charles Roselle for services rendered as teamster and laborer at the Abiquiu agency, New Mexico, in second quarter 1874, being a deficiency for the fiscal year 1874	....do.......	....	....	....	105 00		
Amount due Francisco Griego for hire of team for the service at the Cimarron agency, New Mexico, in April, 1874, being a deficiency for the fiscal year 1874	....do.......	....	....	....	10 00		
Amount due Francisco Griego for services rendered as interpreter at the Cimarron agency, New Mexico, in May, 1874, being a deficiency for the fiscal year 1874	....do.......	....	....	....	55 55		
Amount due W. A. Crocker for services rendered as issue-clerk at the same agency, in May, 1874, being a deficiency for the fiscal year 1874	....do.......	....	....	....	53 33		
Amount due George Schafer for 414 loaves of bread furnished the Indians at the Pueblo agency, New Mexico, in the second quarter 1874, being a deficiency for the fiscal year 1874	....do.......	....	....	....	34 50		
Amount due Francisco Griego for transportation furnished two Indians, witnesses to United States court, from Cimarron to Santa Fé, New Mexico, in February, 1874, being a deficiency for the fiscal year 1874	....do.......	....	....	....	39 00		
Amount due John E. Murphy for medicines furnished for the service in New Mexico during the second quarter 1874, being a deficiency for the fiscal year 1874	....do.......	....	....	....	20 75	$4,345 19	$50,000 00

Estimates of appropriations required by the various Departments, &c.—Continued.

General object. (Title of appropriation.)	Detailed objects of expenditure, and explanations.	Date of acts, resolutions, or treaties, authorizing or providing for the expenditures.	References to Statutes at Large, or to Revised Statutes. Vol. or R. S.	Page.	Sec.	Estimated amount which will be required for each detailed object of expenditure.	Total amount to be appropriated under each head of appropriation.	Amount appropriated for the fiscal year for which the appropriation is required.
	INDIAN AFFAIRS—Continued.							
Incidental expenses, Indian service in Oregon.	This amount, to be applied in payment of salaries due employés, purchases of supplies, &c., during the fiscal year ending June 30, 1874, as per statement of Agent P. B. Sinnott, on file in the Indian Office, being a deficiency for the fiscal year 1874	Feb. 14, 1873	17	460	1	....	$1,606 08	$40,000 00
Incidental expenses, Indian service in Utah.	Amount due Union Pacific Railroad Company for transporting annuity goods and supplies to Indians in Utah during the fiscal year ending June 30, 1874, being a deficiency for the fiscal year 1874	Feb. 14, 1873	17	460	1	$631 45		
	Amount due Pardon Dodds for herding 28 head of cattle at the Uintah Valley agency, Utah, from July 1, 1873, to September 30, 1873, at $50 per month, being a deficiency for the fiscal year 1874	....do	....	....	....	150 00		
	Amount due James M. Barker for services rendered as laborer at the Uintah Valley agency, Utah, during the second quarter 1874, being a deficiency for the fiscal year 1874	....do	....	....	....	150 00		
	Amount due James T. Taylor for services rendered as laborer at the same agency same quarter, being a deficiency for the fiscal year 1874	....do	....	....	....	150 00		
	Amount due Edward B. Critchlow for services rendered as laborer at the same agency same quarter, being a deficiency for the fiscal year 1874	....do	....	....	....	150 00		
	Amount due Robert C. Turner for services rendered as laborer and mail-carrier at the same agency same quarter, being a deficiency for the fiscal year 1874	....do	....	....	....	225 00		
	Amount due Peter Van Houten for services rendered as carpenter at the same agency same quarter, being a deficiency for the fiscal year 1874	....do	....	....	....	300 00		
	Amount due John Kelley for services rendered as blacksmith at the same agency same quarter, being a deficiency for the fiscal year 1874	....do	....	....	....	250 00		
	Amount due Maurice K. Parsons for the delivery under contract of 43,593 pounds of fresh beef during the first and second quarters, 1874, at the same agency, being a deficiency for the fiscal year 1874	....do	....	....	....	4,141 33		

	Amount due Daniel S. Moseby for services rendered as farmer at the same agency during the second quarter, 1874, being a deficiency for the fiscal year 1874	....do	.....	.....	.....	250 00	6,397 78	35,000 00
Incidental expenses, Indian service in Washington.	Amount due John A. Simms, agent for expenses incurred in travelling on business in connection with the service at the Colville agency, Washington Territory, from July 3 to October 7, 1873, being a deficiency for the fiscal year 1874	Feb. 14, 1873	17	460	1	321 77		
	Amount due Union Pacific Railroad Company for transporting annuity goods and supplies to Indians located in Washington Territory during the fiscal year ending June 30, 1874, being a deficiency for the fiscal year 1874	....do	.....	.....	....	54 00	375 77	24,400 00
Contingencies, Indian department.	This amount for travelling expenses of a special agent in Alaska, from July 1, 1873, to June 30, 1874, as per vouchers on file in the Indian Office, being a deficiency for the fiscal year 1874	Feb. 14, 1873	17	440	1	456 54		
	Amount due Dodd, Brown & Co. for goods furnished to relieve the suffering Kickapoo Indian captives at Fort Gibson, Indian Territory, preparatory to removal to a new location, during September and November, 1873, being a deficiency for the fiscal year 1874	....do	.....	.....	.....	565 66		
	Amount due Joseph D. Gurnoe for services rendered as clerk at the La Pointe agency, Wisconsin, in August and October, 1873, being a deficiency for the fiscal year 1874	....do	.....	.....	.....	165 00		
	Amount due J. A. Davis for balance on account for services rendered as superintendent at Red Cliff reservation, Wisconsin, and as clerk to the agent at the La Pointe agency, Wisconsin, from September 1, 1873, to February 6, 1874, being a deficiency for the fiscal year 1874	....do	....	.....	.....	250 00		
	Amount due T. J. Mesick, balance on account, for board of Geo. Busleyhead and wife, North Carolina Cherokee Indians, being a deficiency for the fiscal year 1874	....do	.....			145 37	1,582 57	50,000 00
Settlement, subsistence, and support of Shoshones and Bannocks, and other bands in Idaho and Southeastern Oregon.	Amount due the Union Pacific Railroad Company for transporting annuity goods and supplies to Shoshones and Bannocks, and other bands in Idaho and Southeastern Oregon, during the fiscal year ending June 30, 1874, being a deficiency for the fiscal year 1874	Feb. 14, 1873	17	455	1	....	473 63	40,000 00
Expenses of Indian delegations visiting Washington.	Amount due Union Pacific Railroad Company for transportation furnished Indian delegations visiting Washington during the fiscal year ending June 30, 1874, being a deficiency for the fiscal year 1874	Feb. 14, 1873	17	461	1	....	826 00	15,000 00
Collecting and subsisting Apaches of Arizona and New Mexico.	Amount due J. P. Chase for supplies furnished the Southern Apache agency, New Mexico, during the fiscal year ending June 30, 1874, being a deficiency for the fiscal year 1874	Feb. 14, 1873	17	440	1	563 30		
	Amount due George B. Duncan for services rendered as issue-clerk at Southern Apache agency, New Mexico, in January, 1874, being a deficiency for the fiscal year 1874	....do......	.....	.....	.....	60 00		

Estimates of appropriations required by the various Departments, &c.—Continued.

General object. (Title of appropriation.)	Detailed objects of expenditure, and explanations.	Date of acts, resolutions, or treaties, authorizing or providing for the expenditures.	References to Statutes at Large, or to Revised Statutes. Vol. or R. S.	Page.	Sec.	Estimated amount which will be required for each detailed object of expenditure.	Total amount to be appropriated under each head of appropriation.	Amount appropriated for the fiscal year for which the appropriation is required.
	INDIAN AFFAIRS—Continued.							
Collecting and subsisting Apaches of Arizona and New Mexico—Continued.	Amount due Henry Duane for services rendered as physician at the same agency in fourth quarter 1873, being a deficiency for the fiscal year 1874	Feb. 14, 1873	17	440	1	$200 00		
	Amount due Andrew Berger for services rendered as blacksmith at the same agency in second quarter 1874, being a deficiency for the fiscal year 1874	......do......	.....	.....	.....	33 25		
	Amount due Louis Clark for beef and flour furnished in March, 1874, for Jicarilla Apaches in New Mexico, being a deficiency for the fiscal year 1874	......do......	.....	.....	.....	583 20		
	Amount due Green & Lohenstein for supplies furnished in May, 1874, for Mescalero Apache agency, New Mexico, being a deficiency for the fiscal year 1874	......do......	.....	.....	.....	18 00		
	Amount due Pedro Montaya for erecting school-house in December, 1873, and furnishing 16 tons of hay in August, 1873, for the same agency, being a deficiency for the fiscal year 1874	......do......	.....	.....	.....	224 00		
	Amount due William Rosenthal for corn and hay furnished in September, 1873, for the same agency, being a deficiency for the fiscal year 1874	......do......	.....	.....	.....	168 00		
	Amount due Paul Dowlire for supplies furnished the Mescalero Apache agency, New Mexico, in May, 1874, being a deficiency for the fiscal year 1874	......do......	.....	.....	.....	96 00		
	This amount to be applied to the payment of indebtedness incurred on account of the service at the Gila River agency, Arizona, during the first and second quarters, 1874, as per statement of Agent J. H. Stout, on file in the Indian Office, being a deficiency for the fiscal year 1874	......do......	.....	.....	.....	1,167 50		
	Amount due Thomas Whyte for services as interpreter from January 1 to January 31, 1874, and as farmer from February 1 to June 30, 1874, at Camp Apache agency, being a deficiency for the fiscal year 1874	......do......	.....	.....	.....	456 98		
	Amount due Charles M. Rogers for services as clerk at Camp Apache agency from January 1 to March 31, 1874, being a deficiency for the fiscal year 1874	......do......	.....	.....	.....	150 00		

	Amount due Edwin W. Osborn for 2 mules furnished the Camp Apache agency April 10, 1874, being a deficiency for the fiscal year 1874	do				350 00		
	Amount due John H. Roberts for services as farmer at Camp Apache agency from April 1 to June 30, 1874, being a deficiency for the fiscal year 1874	do				250 00		
	Amount due C. E. Cooley for services as farmer at Camp Apache agency, from January 1 to June 30, 1874, being a deficiency for the fiscal year 1874	do				500 00	$4, 890 23	$250, 000 00
Incidental expenses, Indian service in California.	This amount to be applied in payment of indebtedness incurred on account of the service at the Round Valley agency, California, in the second quarter 1875, as per estimate of Agent J. L. Burchard, on file in the Indian Office, being a deficiency for the fiscal year 1875	June 22, 1874	18	171	1	693 63		
	Amount due Henry Cox for services rendered as inspector of Indian supplies at San Francisco during the fiscal year ending June 30, 1875, being a deficiency for the fiscal year 1875	do				601 00		
	Amount due Marcus C. Hawley & Co. for articles of hardware furnished the Hoopa Valley agency, in California, in July, 1874, being a deficiency for the fiscal year 1875	do				70 50		
	This amount to meet liabilities contracted on account of the service at the Hoopa Valley agency, California, during the fiscal year ending June 30, 1875, being for annuities purchased of the following parties, namely: Fleishman, Sichel & Co., $1,501 94; Murphy, Grant & Co., $631 63; C. H. Myers & Bro., $60 19; Fordham & Jennings, $760 98; Levi Strauss & Co., $496 59; J. C. Johnson & Co., $37 27; Dutton & Wythington, $74 62; Mission and Pacific Woollen Mills, $3,463 73; Crane & Brigham, $113 17; and Hecht Bros. & Co., $445 08, aggregating $7,585 10, being a deficiency for the fiscal year 1875	do				7, 585 10	8, 950 23	70, 000 00
Incidental expenses, Indian service in Dakota.	Amount due Albertie & Brenner for medicines furnished the Ponca Indians in December, 1874, being a deficiency for the fiscal year 1875	June 22, 1874	18	171	1	67 30		
	Amount due Wyman, Buckwalter & Co. for hardware furnished the Ponca agency in December, 1874, being a deficiency for the fiscal year 1875	do				30 86		
	Amount due Blall & Buerdorft for sundry articles furnished the same agency in January, 1875, being a deficiency for the fiscal year 1875	do				5 85	104 01	20, 000 00
Contingencies, Indian department.	Amount due Gibson & Tyler, balance on blankets furnished under contract for the service at Leech Lake agency, Minnesota, during the fiscal year ending June 30, 1876, being a deficiency for the fiscal year 1876	March 3, 1875	18	423	1		1, 882 09	30, 000 00
Pay of special agents	Amount due to James Brown for services rendered and expenses incurred as special Indian agent in Oregon from July 1, 1875, to January 31, 1876, as per vouchers on file in the Indian Office, being a deficiency for the fiscal year 1876	March 3, 1875	18	421	1		1, 170 33	10, 500 00

Estimates of appropriations required by the various Departments, &c.—Continued.

General object. (Title of appropriation.)	Detailed objects of expenditure, and explanations.	Date of acts, resolutions, or treaties, authorizing or providing for the expenditures.	References to Statutes at Large, or to Revised Statutes. Vol. or R. S.	Page.	Sec.	Estimated amount which will be required for each detailed object of expenditure.	Total amount to be appropriated under each head of appropriation.	Amount appropriated for the fiscal year for which the appropriation is required.
	INDIAN AFFAIRS—Continued.							
Incidental expenses, Indian service in California.	Amount due the Mission and Pacific Woollen Mills of San Francisco, California, for goods furnished Round Valley agency in October, 1875, under contract of July 19, 1873, being a deficiency for the fiscal year 1876	March 3, 1875	18	445	1		$3,303 20	$60,000 00
Incidental expenses, Indian service in Oregon.	Amount due L. Goldsmith & Co., assignees, being Indian payrolls, of amounts due employés at the Siletz agency, Oregon, for the fiscal year ending June 30, 1876, being a deficiency for the fiscal year 1876	March 3, 1875	18	443	1		1,663 00	45,000 00
Collecting and subsisting Apaches of Arizona and New Mexico.	Amount due the Mission and Pacific Woollen Mills for five hundred coats furnished for Colorado River and San Carlos agencies, in November, 1875, under contract of July 19, 1873, being a deficiency for the fiscal year 1876	March 3, 1875	18	423	1		4,166 66	450,000 00
Fulfilling treaty with Shoshones and Bannocks.	Amount due the War Department for beef furnished the Shoshones in Wyoming, in July and August, 1876, being a deficiency for the fiscal year 1877	Aug. 15, 1876	19	190	1		4,137 56	77,111 00
Survey of the Black Hills	Balance due Walter P. Jenney, late geologist in charge, survey of the Black Hills in Dakota, from July 1, 1876, to February 15, 1877, as shown on settlement of his accounts, being a deficiency for the fiscal year 1877	July 31, 1876	19	120	1		1,888 62	14,000 00
Support of Indian prisoners of war at Fort Marion, Florida.	This amount to reimburse the War Department for subsistence stores, clothing, &c., furnished from July 1, 1876, to August 31, 1877, to 67 Indians held as prisoners of war at Fort Marion, Florida	Submitted				$6,823 35		
	For the care, subsistence, and clothing of same Indians up to June 30, 1878, this amount or so much thereof as may be necessary	do				5,000 00	11,823 35	
Presents to Indians, (transfer account.)	To effect a transfer to close the accounts of Nicholas Boilvin, Indian agent, involving no expenditure of money from the Treasury, being for the fiscal year 1873, and prior years, $3,148 26.							

Contingencies, Indian department.	This amount to reimburse H. M. Rice for services rendered and expenses incurred as special commissioner in investigating affairs at the White Earth reservation, Minnesota, from July 11 to August 10, 1877 being a deficiency for 1878	March 3, 1877	19	272	2	....	260 80	30,000 00
Contingencies of the Indian department.	Amounts found due, as per certificate of the accounting officers, as follows:							
	Charles T. Brown, late Indian agent, $95 80; George A. Crowell, late Indian agent, $171 77; being a deficiency for the fiscal year 1873, and prior years	May 29, 1872	17	166	1	....	267 57	50,000 00
	Amount due George A. Crowell, late Indian agent, as per certificate of the accounting officers, being a deficiency for the fiscal year (1874) 1873	Feb. 14, 1873	17	440	1	....	107 16	50,000 00
Incidental expenses, Indian service in Dakota	Amounts found due for supplies, services, &c., as per certificate of the accounting officers, as follows: Wm. Rowland, jr., $6; Charles Jarvis, $9; John H. Bridgman, $60; Peter Bissonette, $900; Addoms & Glover, $56 25; William Harmon, $509 79; Hanna & Murphy, $79; George O'Brien, $48 15; Alfred T. Lobach, $84; H. Haas, $51 50; Antoine Barrett, $12; L. W. Brewer, $120; C. de L. Benevathis, $8; John Farnham, $30; George Gafney, $30 59; Patrick Hays, $150; Antoine Jarvis, $12; Joseph Kamen, $150; John Liddeau, $9; John Proveau, $6; Wm. Rowland, $121 66; Wm. Rowland, $150; Manuel Romero, $21; Frank Salvia, $55; Lezic, (half-breed,) $28; Todd Randall, $63; Thos. Monahan, $300; in all, $3,129 94; being deficiency for the fiscal year (1874) 1873	Feb. 14, 1873	17	460	1	....	3,129 94	20,000 00
Incidental expenses, Indian service in Nevada.	Amount due J. P. C. Shanks, late Indian agent, as per certificate of the accounting officers, being a deficiency for the fiscal year 1875	June 22, 1874	18	171	1	....	131 11	15,000 00
Fulfilling treaties with Ottoes and Missourias.	Amount due Albert L. Green, late Indian agent, as per certificate of the accounting officers, being a deficiency for the fiscal year 1873, and prior years	May 29, 1872	17	177	1	....	84 64	9,000 00
Trust-fund interest due Choctaw orphans' reservations.	Amount due Charles Borland, late commissioner to the Choctaws, as per certificate of the accounting officers, being a deficiency	Jan. 9, 1837	5	135	1	....	1 98	
	NOTE.—Of the amount covered into the Treasury on account of proceeds of Choctaw orphan lands in Mississippi, the sum of $7 50 remained unexpended, and was carried to the surplus fund August 26, 1871.							
Care of certain stray bands of Winnebagoes and Pottawatomies.	Amount due John T. Kingston, late special agent, as per certificate of the accounting officers, being a deficiency for the fiscal year 1873, and prior years	April 10, 1869	16	38	1	....	7 25	5,000 00

Estimates of appropriations required by the various Departments, &c.—Continued.

General object. (Title of appropriation.)	Detailed objects of expenditure, and explanations.	Date of acts, resolutions, or treaties, authorizing or providing for the expenditures.	References to Statutes at Large, or to Revised Statutes. Vol. or R. S.	Page.	Sec.	Estimated amount which will be required for each detailed object of expenditure.	Total amount to be appropriated under each head of appropriation.	Amount appropriated for the fiscal year for which the appropriation is required.
	INDIAN AFFAIRS—Continued.							
Negotiating treaty with Sioux of the Upper Missouri.	Amount due S. D. Hinman, late special agent and commissioner, as per certificate of the accounting officers, being a deficiency for the fiscal year 1873, and prior years	March 29, 1867	....	....	....	....	$25 48	$15,000 00
Purchase of wagons, teams, tools, &c., for Northern superintendency.	Amount due Albert L. Green, late Indian agent, as per certificate of the accounting officers, being a deficiency for the fiscal year 1873, and prior years	July 15, 1870	16	359	1	....	2 53	30,000 00
Removal and subsistence of Indians in California to reservations, and pay of physician, smith, &c.	Amounts due for goods and provisions furnished the Indians on the Fresno and King's River reservation in 1859, as per certificate of the accounting officers, as follows: To John J. Blair, $725 72; to Levi Mitchell, $44 08; being a deficiency for the fiscal year 1873, and prior years	March 3, 1857	11	183	1	....	769 80	162,000 00
	Total Interior Department	....	....	....	....	....	301,381 96	5,671,891 76
	POST OFFICE DEPARTMENT.							
Deficiency in the postal revenues.	Amount due F. A. Wilson on contract for carrying the mails on postal route No. 15,281 for the 2d quarter, 1866, as per letter of the Sixth Auditor of the Treasury and certificate of the Commissioner of Customs, being a deficiency for the fiscal year 1871, and prior years	Submitted	....	....	....	$1,500 00		
	To pay Texas and New Orleans Railroad Company for services in transporting the mails between New Orleans and Indianola, La., from April 1 to June 30, 1867, (route No. 8,501,) being a deficiency for the fiscal year 1871, and prior years	....do	....	....	....	577 16		
	To pay T. A. Kendig for carrying the mails in Louisiana from November 1, 1866, to June 30, 1867, (routes No. 8108 and 8109,) being a deficiency for the fiscal year 1871, and prior years	....do	....	....	....	4,099 44	$6,176 60	

	NOTE.—No appropriation was made for deficiencies in the postal revenues in the years 1866 and 1867.							
	Total Post Office Department						6,176 60	
	DEPARTMENT OF JUSTICE.							
Contingent expenses, Department of Justice.	Stationery: To pay Wm. H. Dempsey's bill of February 17, 1875, for stationery	June 20, 1874	18	109	1		$3 75	$2,500 00
	Miscellaneous items: To pay balance of account of the item for advertising proposals for stationery	do					46 55	6,000 00
	Being deficiencies for the fiscal year 1875.							
	Miscellaneous items: To pay the Atlantic and Pacific Telegraph Company for telegraphing during the months of April, May, and June, 1876	March 3, 1875	18	369	1	55 18		
	To pay Lutz & Bro.'s bill of June 30, 1876, for sundries	do				41 00		
							96 18	6,000 00
	Repairs to wagons and harness: To pay Lutz & Bro.'s bill for repairing harness	do					26 00	600 00
	Being deficiencies for the fiscal year 1876.							
	Miscellaneous items: To pay the Atlantic and Pacific Telegraph Company for telegraphing in October, 1876	Aug. 15, 1876	19	168	1		9 10	739 73
	Care and subsistence of horses and repairs of wagons and harness: To pay Andrew Joyce for repairs to carriages from July to November, 1876	do				14 85		
	To pay Wash. Nailor for one month's livery of one horse, for June, 1877	do				25 00		
	Being deficiencies for the fiscal year 1877.						39 85	1,000 00
	NOTE.—By act of January 26, 1877, $11,000 was appropriated for all the contingent expenses of the Department of Justice for the fiscal year 1877, in consequence of omissions in enrolling act "making appropriations for the legislative, executive, and judicial expenses of the Government for the year ending June 30, 1877."							
	For estimated amount required for the purpose of the appropriation for care and subsistence of horses and repairs of wagons and harness, being a deficiency for the year 1878	March 3, 1877	19	318	1		250 00	750 00
Defending suits and claims for seizure of captured and abandoned property.	Amount estimated to carry out the purposes of the appropriation for payment of the necessary expenses incurred in defending suits against the Secretary of the Treasury, or his agents, for the seizure of captured or abandoned property, and for the examination of witnesses in claims against the United States pending in any Department, and for the defence of the United States in the Court of Claims, being a deficiency for the fiscal year 1878	March 3, 1877	19	346	1		5,000 00	25,000 00

Estimates of appropriations required by the various Departments, &c.—Continued.

General object. (Title of appropriation.)	Detailed objects of expenditure, and explanations.	Date of acts, resolutions, or treaties, authorizing or providing for the expenditures.	References to Statutes at Large, or to Revised Statutes. Vol. or R. S.	Page.	Sec.	Estimated amount which will be required for each detailed object of expenditure.	Total amount to be appropriated under each head of appropriation.	Amount appropriated for the fiscal year for which the appropriation is required.
	DEPARTMENT OF JUSTICE—CONTINUED.							
Salaries, district attorneys.	Amount due D. J. Baldwin, United States attorney for the eastern district of Texas, balance of salary as per certificate of the accounting officers of the Treasury Department, being a deficiency for the fiscal year 1874	March 3, 1873	17	507	1	....	$38 34	$19, 350 00
Salaries, district marshals.	Amount due Francis H. Goodwin, late United States marshal, district of Arizona, being part of his salary from January 11, 1875, to June 30, 1876, as per letter of the First Comptroller of the Treasury, being deficiencies, as follows:							
	For the fiscal year 1875	June 20, 1874	18	108	1	....	94 47	11, 900 00
	For the fiscal year 1876	March 3, 1875	18	369	1	....	28 29	11, 900 00
	JUDICIAL.							
Expenses of United States courts.	For defraying the expenses of the Supreme Court and circuit and district courts of the United States, including the District of Columbia; and also for jurors and witnesses, and expenses of suits in which the United States are concerned, of prosecutions for offences committed against the United States; for the safe-keeping of prisoners, and for defraying the expenses which may be incurred in the enforcement of the act of February twenty-eight, eighteen hundred and seventy-one, relative to the right of citizens to vote, or any acts amendatory thereof or supplementary thereto, being a deficiency for the fiscal year 1877	July 31, 1876 Nov. 21, 1877, pamphlet laws.	19	107	1	....	110, 000 00	2, 708, 057 50
	NOTE.—For explanation of this estimate, see Appendix, marked "O."							
Support of convicts	For the support and maintenance of convicts transferred from the District of Columbia, being a deficiency for the fiscal year 1878	March 3, 1877	19	346	1	....	8, 000 00	4, 000 00
	NOTE.—For explanation of this estimate, see Appendix, marked "O."							
	Total Department of Justice	....	.....	.....	.....	....	123, 632 53	2, 797, 797 23

RECAPITULATION.

State Department							$85,270 44	$2,664,913 00
Court of Claims							503,374 12	639,370 59
Treasury Department							483,204 38	12,847,881 06
War Department							1,255,780 01	13,551,150 00
Interior Department							301,381 96	5,671,891 76
Post Office Department							6,176 60	
Department of Justice							123,632 53	2,797,797 23
Grand total							2,678,820 04	38,172,303 64

APPENDIX.

APPENDIX A.

List of Judgments rendered by the United States Court of Claims, due and unpaid February 6, 1878. (*See page* 3.)

Date of judgment.	Date of presentation for payment.	Name of claimant.	Amount of judgment.	Amount of set-off claimed by United States.	Remarks.
May 24, 1875	July 21, 1875	State National Bank of Boston	*$480,000 00		Affirmed by Supreme Court, October term, 1877.
Apr. 17, 1876	May 18, 1876	James A. White and Augustus R. Montgomery	3,443 50	$608 00	Do. do. do.
Apr. 17, 1876	May 18, 1876	E. E. Norton, assignee in bankruptcy of B. P. Ethell	3,856 72	680 00	Do. do. do.
Apr. 17, 1876	May 18, 1876	E. E. Norton, assignee in bankruptcy of Samuel De Bon & Co	3,208 66	1,000 00	Do. do. do.
Apr. 17, 1876	May 23, 1876	J. A. Bonnafon	2,066 10	376 00	Do. do. do.
June 1, 1876	June 8, 1876	Charles Roman and O. Charles Olivier	3,971 96		Do. do. do.
June 1, 1876	June 8, 1876	Edward A. Yorke	725 00		Do. do. do.
June 1, 1876	June 8, 1876	E. E. Norton, assignee in bankruptcy of D. Cerf	1,461 52		Do. do. do.
June 1, 1876	June 8, 1876	Jonas H. Levy and Anderson D. Dieter	1,454 00		Do. do. do.
June 11, 1877	Jan. 10, 1878	Irving F. Wilcox	1,020 00		Do. do. do.
Dec. 10, 1877		Selucius Garfielde	2,166 66		On mandate of Supreme Court.
		Total	503,374 12		

*In gold coin.

The foregoing judgments, except that in favor of Selucius Garfielde, bear interest from the respective dates of presentation for payment until paid, at five per centum per annum, under section 1090, Revised Statutes.

Against the judgments in favor of White and Montgomery; Norton, assignee in bankruptcy of Ethell; Norton, assignee in bankruptcy of De Bon & Co.; and J. A. Bonnafon, the United States claims set-offs of the amount of internal-revenue tax due, as above set forth.

APPENDIX B.

Explanation of estimate for Salaries, Office of Sixth Auditor. (*See page* 4.)

OFFICE OF THE AUDITOR OF THE TREASURY
FOR THE POST OFFICE DEPARTMENT,
Washington, December 11, 1877.

SIR: I have the honor to request your attention to an error affecting the clerical force of this office, in the appropriation for salaries for the current fiscal year, (19 Stat., p. 301,) as follows, viz., "twenty assorters of money-orders, eighteen thousand dollars."

Under the act approved March 3, 1875, (18 Stat., Part 3, p. 397,) this office is entitled to twenty assorters of money-orders at *one thousand* dollars per annum.

By reference to the act of March 3, 1877, appropriating salaries for the current fiscal year, I find that the bill, as it originally passed the House of Representatives, called for *eighteen* assorters and appropriated *eighteen* thousand dollars. Upon representations made to the Appropriation Committee of the Senate, that committee agreed to restore the number to *twenty*, in accordance with the law, and did so restore the number, but in the final engrossing of the bill the *amount* appropriated was not changed, but remained at eighteen thousand dollars. That such was the intention of the law is established by the fact that in the total amount appropriated for this office, viz., three hundred and ten thousand four hundred and seventy dollars, the twenty assorters are included at *one thousand dollars each.*

The question having been submitted to the First Comptroller, that officer decided that these assorters could be paid only at the rate of nine hundred dollars per annum, and they are now being paid at that rate.

In view of the fact that these persons are but poorly paid at one thousand dollars per annum, that nearly all of them have families or other relatives dependent upon them, and that they are faithful and efficient employés of this office, I have the honor to recommend that the attention of the proper committee of Congress be called to this matter, in the hope that by proper legislation they may be enabled to receive their legal salary from July 1, 1877, to the end of the present fiscal year.

I am, respectfully, your obedient servant,

J. M. McGREW,
Auditor.

Hon. JOHN SHERMAN,
Secretary of the Treasury.

APPENDIX C.

Relating to estimate for Legislative Expenses, Territory of Dakota. (*See page* 4.)

TREASURY DEPARTMENT,
First Comptroller's Office, January 18, 1878.

SIR: I have the honor to return herewith an estimate of deficiency for legislative expenses, Territory of Dakota, 1877, accompanied by two

letters of the territorial secretary relating thereto, referred to me for recommendation.

I find, upon examination, that of the amount of $20,000 appropriated by act of August 15, 1876, for the purpose and fiscal year referred to, the secretary has disbursed, and accounted for the sum of $19,998 57, leaving due the United States, $1 43. On his bill for public printing, amounting, originally, to $2,567 15, and reduced by measurement in this office to $2,542 32, he has paid to the firm of Bowen & Kingsbury, printers, $1,466 07, leaving due them, $1,076 25, as stated in his estimate. The amounts entered on estimate for pay of porter, clerk-hire, and rent, comprise such periods as are not embraced in his account, and the amounts stated to be required for per diem and mileage of members of the legislative assembly appear also to be properly due. No information being in my possession on which to express an opinion as to the other items appearing in the estimate, as needed for miscellaneous printing, blanks, and stationery, fuel, lights, postage, and incidental expenses of the secretary's office, amounting in all to $896 70, I have no recommendation to make.

Very respectfully,

R. W. TAYLER,
Comptroller.

Hon. JOHN SHERMAN,
Secretary of the Treasury.

APPENDIX D.

Relating to the estimate for Legislative Expenses, Territory of Idaho.
(*See page* 5.)

TREASURY DEPARTMENT,
First Comptroller's Office, January 29, 1878.

SIR: I have the honor to return herewith an estimate of deficiency for legislative expenses, Territory of Idaho, fiscal year 1877, referred to me for recommendation, as shown by endorsement on the letter of E. J. Curtis, secretary of said Territory, accompanying the estimate.

I have examined the account of the territorial secretary, and find that his payments for per diem and mileage of the members of the legislative assembly, and per diem of the subordinate officers of that body, as fixed by law, amounted to $17,545 20, and that he has disbursed in all, and accounted for, the sum of $19,784 84, leaving due the United States a balance of $215 16 of the total amount appropriated by act of August 15, 1876, for the purpose and fiscal year referred to, and advanced to him.

The deficiency estimate, as submitted by Mr. Curtis, calls for $6,152 76, from which I have deducted the amount of $511 46 on the bills for printing the laws and journals, by the measurement of the specimens furnished, leaving a balance of $5,641 30 to be provided for; but, as the territorial secretary has not asked my advice in anything

pertaining to his expenditures, I respectfully decline to make any recommendation.

Very respectfully,

R. W. TAYLER,
Comptroller.

Hon. JOHN SHERMAN,
Secretary of the Treasury.

APPENDIX E.

Explanation of the estimate for Legislative Expenses, Territory of New Mexico. (*See page* 6.)

TREASURY DEPARTMENT,
First Comptroller's Office, January 25, 1878.

SIR: I have the honor to acknowledge the receipt of an estimate of deficiency in the appropriation for legislative expenses, Territory of New Mexico, accompanied by a letter of W. G. Ritch, secretary of said Territory, dated October 6, 1877, referred to me by the chief clerk of the Department under date of December 14, "for a statement of the amounts chargeable to legislative expenses, Territory of New Mexico, reference to which is made in the enclosed estimate and letter of the secretary of the Territory; and also for recommendation."

Returning herewith the estimate, I recommend that Congress be requested to appropriate the amount of $1,448 13 due to Manderfield & Tucker, as therein stated. The bills for printing executed by that firm, for the 22d session of the legislative assembly, (fiscal year 1876,) amounted in all to $5,904 47½; they were reduced in this office by the measurement of specimens of laws, journals, bills, &c., furnished, to $5,448 13, of which amount I could only authorize the Secretary to pay $4,000 under the law limiting the disbursement for printing during any session to that sum.

In recommending that the unpaid balance of $1,448 13 be provided for, I beg to state that New Mexico is one of the two Territories in which the printing is done in two languages.

* * * * * * *

Very respectfully,

R. W. TAYLER,
Comptroller.

Hon. JOHN SHERMAN,
Secretary of the Treasury.

APPENDIX F

Explanation of estimates for the Internal-Revenue Service. (*See page* 8.)

TREASURY DEPARTMENT,
Office of Internal Revenue, Washington, October 31, 1877.

SIR: I desire to call your attention, specially, to the two items recommended to be appropriated for deficiencies in the internal-revenue ser-

vice, viz: Forty thousand dollars on account of "salaries and expenses of collectors," and one hundred and fifty thousand dollars on account of "salaries and expenses of agents, surveyors, gaugers," &c.

The allowances for collectors that have been recommended for your approval have not created, and will not create, a deficiency in the appropriation, but the needs of the service are so urgent that I deem it for the best interests of the Government that this appropriation of forty thousand dollars should be made. It is intended, mainly, for the purpose of suppressing frauds in the manufacture and sale of spirits and tobacco.

The item of one hundred and fifty thousand dollars is necessary to provide for the pay of storekeepers and gaugers during the current fiscal year. For the fiscal year ending June 30, 1877, the sum of $1,590,000 was required for that purpose.

The appropriation for the current fiscal year is $1,450,000, which I am satisfied is inadequate for the purpose for which it was designed.

I have the honor to be, very respectfully,

GREEN B. RAUM,
Commissioner.

Hon. JOHN SHERMAN,
Secretary of the Treasury.

APPENDIX G.

Explanation of the estimate for Punishment for Violation of Internal-Revenue Laws. (*See page* 8.)

TREASURY DEPARTMENT,
Office of Internal Revenue, January 16, 1878.

SIR: The appropriation for "punishment for violation of internal-revenue laws" for the year ending June 30, 1876, has been entirely expended; and there is a claim of J. D. Sanborn for $1,000, properly payable from this fund, being the claim in case of Erie and Pittsburgh Railroad Company, approved by the Secretary in December for $1,461 39; $461 39 of which has been paid, leaving $1,000 unpaid as stated.

It is thought that there are also a number of similar claims accruing in the same period that will eventually be perfected, for which there will be no provision for payment unless an additional appropriation is granted. These services were rendered under the provisions of Circular No. 99, offering a reward for information leading to the collection of unpaid and over-due taxes. In all such claims allowed, it is shown that the Government has realized the benefit from the information furnished, in the actual collection of the taxes; and although the offer in that circular is limited to the sum appropriated therefor, it was impossible to anticipate the amount of claims that might be presented under that offer, so as to restrict the *pro rata* of the allowance of those first presented and paid; and in fact the aggregate of these claims is much less than the amount of the appropriation, the balance of the appropriation having been expended in the unusual expenses incurred in that year in suppressing violations of internal-revenue laws.

In view of these facts I would request that Congress be asked to make an additional appropriation of $5,000 under the above title, for the period from July 1, 1875, to June 30, 1876.

Respectfully,

GREEN B. RAUM,
Commissioner.

Hon. JOHN SHERMAN,
Secretary of the Treasury.

APPENDIX H.

Explanation of estimates for Contingent Expenses, Treasury Department.
(*See page* 9.)

TREASURY DEPARTMENT,
Office of the Secretary, January 10, 1878.

SIR: I have to request that you cause estimates to be made for a deficiency appropriation of six thousand dollars for gas, and two thousand dollars for horses and wagons, in contingent expenses of Treasury Department for 1877–'78.

The appropriation for gas for the fiscal year 1877–'78 is $12,500, but owing to the extensive repairs made to the heating apparatus of the Department during the past eight months, necessitating the employment of a large force of men during the whole of every night for that period, the consumption of gas has necessarily been nearly doubled, and now, at the expiration of six months of the fiscal year, more than two-thirds of the sum appropriated for this item has been expended, and it is a matter of absolute necessity that a deficiency appropriation of the amount above stated be made to defray the expense of gas during the remainder of the year.

The appropriation for horses and wagons for the year 1875–'76 was $6,000, and for the year 1876–'77, $3,400. At the close of the fiscal year 1875–'76 the carriages, wagons, and harness were in good repair, and the year 1876–'77 was entered upon with a full supply of feed for the horses and a good outfit in wagons, harness, &c., thus enabling the custodian, by close management, to pass the year without requesting additional appropriation.

The year 1877–'78, however, was begun with empty feed-boxes, dilapidated harness, and shabby carriages and wagons, thus compelling an immediate outlay to replenish the stock of stable and to put in repair the carriages, wagons, and harness, from the smallest appropriation—$3,200—that has been made for horses and wagons for this Department for many years.

The sum of $3,200 is not sufficient to meet the expenses attending the care and feeding of the horses, repairing carriages, wagons, and harness, and paying the salaries of two hostlers and one driver. The pay of three men—$720 each per annum—amounts to $2,160 per year, leaving for the purposes of repairs and purchase of harness, repairs to wagons and carriages, and bills for feed of horses, only $1,040.

The expense for board per year for eight horses, the number found necessary to keep, estimated at $20 per month, each, amounts to $1,920.

The items of salaries for two hostlers and one driver, $2,160, and board for eight horses, estimated at $1,920, would be $4,080. This sum exceeds by $880 the amount appropriated, with no provision for expense of repairs to carriages, wagons, and harness, and other incidental expenses necessarily arising in the maintenance of a stable for eight horses, two carriages, and three wagons. There is, at this date, a balance of only $849 65.

In view of the facts above stated, there is a most urgent necessity for an additional appropriation of $2,000, to meet expenses for horses and wagons during the remainder of the present fiscal year.

Very respectfully,

O. L. PITNEY,
Custodian.

J. K. UPTON,
Chief Clerk, Treasury Department.

APPENDIX I.

Explanation of the estimate for Repairs and Preservation of Public Buildings. (*See page* 10.)

TREASURY DEPARTMENT,
Office of the Supervising Architect, January 12, 1878.

SIR: I have the honor to call your attention to the advisability of securing, if possible, an advance appropriation for the repairs and preservation of public buildings.

The sum of one hundred and fifty thousand dollars ($150,000) was estimated as required for this service during the present fiscal year, but only one hundred thousand dollars ($100,000) was appropriated, a sum insufficient to meet the requirements of about one hundred and forty (140) public buildings dependent upon this appropriation for the needed repairs and such alterations as are from time to time demanded by the exigencies of the public service.

The appropriation for this purpose for the fiscal year ending June 30, 1877, was one hundred and fifty thousand dollars, ($150,000,) and expenditures were authorized therefrom to cover the full amount. Authorizations from the appropriation for the present fiscal year have also been made to within about five thousand dollars ($5,000) of the amount appropriated; and as the regular appropriation bill will not, probably, be passed for some months, and at this season of the year it is often necessary that repairs should be promptly placed upon buildings in order to prevent great damages, I would respectfully recommend that Congress be asked to make, at an early day, an appropriation of twenty-five thousand dollars, ($25,000,) to meet the demands of this service during the remainder of the present fiscal year.

Very respectfully,

JAS. G. HILL,
Supervising Architect.

Hon. JOHN SHERMAN,
Secretary of the Treasury.

APPENDIX J.

Statement of appropriations required to be used as transfers to close customs officers' accounts now standing on the books of the Treasury. (*See page* 10.)

Name.	Designation.	Location.	Appropriation.	Amount.
Joseph Berry	Col. customs	Bath, Maine	Fencing, &c., site of custom-house, Bath, Maine.	$2,381 00
Joseph W. Cake	do	Philadelphia, Pa.	Revenue-cutter Service, 1869	192 85
			Appraisers' stores	113 84
			Repairs and preservation of public buildings, 1869.	176 90
R. W. Daniels	do	Buffalo, N. Y.	Repairs and preservation of public buildings, 1874.	1,000 00
Perry Fuller	do	New Orleans, La.	Re-establishing lights on southern coast.	17,412 18
Andrew J. Goss	do	St. Augustine, Fla.	Repairs and preservation of public buildings, 1874.	7 18
E. B. Hunt	Top. engineer		Keeper's dwelling, Seine Rock, R. I.	48 91
John H. Harmon	Col. customs	Detroit, Mich	Light-house establishment; keeping buoys in order, 1857.	105 71
			Contingent expenses; construction of marine hospital.	570 53
Charles James	do	San Francisco, Cal.	Custom-house, 1865	1,974 69
			Repairs, custom-house and marine hospital, 1866.	10,155 52
James Johnson	do	Savannah, Ga	Light-house establishment, 1871; supplies for light-houses.	58 20
			Light-house keepers' salaries	445 83
			Seamen's wages, &c	1,925 07
			Repairs, &c., Tybee light	726 26
Howard Stansbury	Top. engineer		Repairs, light, pierhead, Huron	338 32
Edward Spottswood	Surv. customs	Dubuque, Iowa	Contingent expenses; construction of custom-house.	236 14
W. G. Vance	Col. customs	Key West, Fla	Fuel, &c., 1871	153 58
			Fuel, &c., 1872	254 08
			Furniture and repairs, 1872	17 45
Wylly Woodbridge	do	Savannah, Ga	Light-house establishment; light-house keepers' salaries, 1871.	794 50
F. A. Wilson	do	Puget Sound, W. T.	Revenue-cutter Service, 1870	5,078 32
			Light-house establishment; light-house keepers' salaries, 1870.	8,122 35
J. B. Wheeler	Top. engineer	11th light-house district.	Beacon-light, end of pier, Chicago, Ill.	1 20
Wm. A. Newell	Supt. Life-saving Service.	New Jersey	Salary	210 08
Patrick H. Jones	Disb. agent	New York	Fuel, &c., 1873	1,711 49
F. A. Wilson	Col. customs	Puget Sound, W. T.	Contract for carrying the mails on Postal Route No. 15,281, 2 qr., 1866.	1,484 58
				55,696 69

APPENDIX K.

Schedule of claims embraced in the estimates submitted by the Secretary of War. (*See pages* 12 *and* 15.)

ARMY TRANSPORTATION, 1873.—(Deficiency, $451,096 34; reappropriation, $281 32.)

No. of claim.	Claimant.	No. of sett.	Date.	Amount.
40,527	A. A. Coffin	2111	Jan. 18, 1877	$130 00
44,221	Bofinger & Pegram, agents	4027	June 9, 1877	4 83
40,480	Estate of Owen Murray	3942	June 5, 1877	25 00
31,847	D. D. McFagden	4461	Aug. 12, 1877	59 50
44,313	Virginia & Truckee Railroad Company, (whole amount, $192; balance under 1874, '75, '76)	4589	Sept. 28, 1877	65 50
33,063	Central Vermont Railroad Company, ($2 75 under 1874)	4724	Sept. 18, 1877	35 82
45,103	Atlantic and Pacific Railroad Company, (lessee of Missouri Pacific)	4798	Nov. 10, 1877	517 23
				837 88
	Aggregate of sundry settlements: Union Pacific Railroad Co. $313,654 03; Kansas Pacific Railroad Co. 86,369 40; Sioux City Pacific Railroad Co 2,914 69; Central Pacific Railroad Co. 47,601 66	....	Various dates.	450,539 78
	Total	......	....	451,377 66

ARMY TRANSPORTATION, 1875.—(Deficiency.)

44,112	Texas and Pacific Railroad Company, (in part)	3853	May 29, 1877	$11 50
40,480	Estate of Owen Murray	3942	June 5, 1877	25 00
42,857	Union Pacific Railroad Company	3662	Apr. 30, 1877	10,301 73
42,859	Union Pacific Railroad Company	3745	May 8, 1877	6,629 46
42,861	Union Pacific Railroad Company	3663	May 8, 1877	14,774 60
44,320	Richmond, Fredericksburg, and Potomac Railroad Company; $236 38 *paid* out of appropriation for 1876, leaving balance of	4242	July 17, 1877	22 21
44,019	Union Pacific Railroad Company, (for the part, $4,625 16, payable from appropriation for 1876, requisition has issued)	4203	Aug. —, 1877	1,613 13
42,860	Union Pacific Railroad Company, (paid in part and part charged to 1874)	4204	Aug. —, 1877	7,356 84
43,959	Union Pacific Railroad Company, (part *paid* from 1876)	4191	Aug. —, 1877	474 92
42,903	Union Pacific Railroad Company, (part *paid* from 1876)	4224	Aug. —, 1877	383 53
39,938	Jeffersonville, Madison, and Indianapolis Railroad Company	4353	Aug. 9, 1877	14 16
44,145	Union Pacific Railroad Company, (the residue, $5,432 30, is *payable* from appriation for 1876, which is still existing)	4548	Sept. 11, 1877	6,037 31
44,292	Union Pacific Railroad Company, (A. T., 1874, $8,542 93; A. T., 1876, $5,130 84)	4567	Sept. 14, 1877	36,421 31

Schedule of claims, &c.—Army transportation, 1875—Continued.

No. of claim.	Claimant.	No. of sett.	Date.	Amount.
44,313	Virginia and Truckee Railroad Company, (whole amount allowed is $192; the balance is under 1873, '74, '76)	4589	Sept. 28, 1877	$17 50
44,366	Union Pacific Railroad Company, (am't of settlement, $40,619 63; the balance under 1874, '76)	4592	Sept. 28, 1877	35,667 17
44,344	Union Pacific Railroad Company, (am't of settlement, $53,959 65; the balance is under 1876)	4591	Sept. 28, 1877	28,539 62
	Lieut. Jas. E. H. Foster, (settlement made by Q. M. Division)	4616	Oct. 8, 1877	184 00
44,808	Central Vermont Railroad Company, ($52 26 under 1876)	4722	Oct. 18, 1877	44 40
45,148	Atlantic and North Carolina Railroad Company, ($6 80 under 1874)	4761	Oct. 27, 1877	18 40
45,152	Annapolis and Elk-Ridge Railroad Company	4760	Oct. 27, 1877	1 36
45,149	Atlantic and North Carolina Railroad Company	4778	Nov. 3, 1877	5 72
44,170	Union Pacific Railroad Co., ($23,764 98 under 1874)	4799	Nov. 10, 1877	5,994 52
44,947	Otto Uhlig	4861	Nov. 13, 1877	2,170 93
	Maj. J. H. Nelson, paymaster, (settlement by Q. M. Division)	5010	Nov. 30, 1877	104 35
45,393	Memphis and Charlestown Railroad Company	5062	Dec. 7, 1877	2 05
44,842	John W. Power, ($2,843 01 paid from A. T., 1876)	5240	Dec. 22, 1877	7 35
	Total			156,823 07

BARRACKS AND QUARTERS, 1871 AND PRIOR YEARS.—(Deficiency, $33,433 44; reappropriation, $27 12.)

35,760	Lucinda Trimble, administrator, &c	3038	Dec. 4, 1874	$2,933 33
34,339	Michael Chester	1996	Jan. 8, 1877	791 66
39,634	William Seigmund, (in part)	2158	Jan. 22, 1877	60 00
39,322	James Taylor	2236	Feb. 5, 1877	1,000 00
42,459	J. T. D. Wilson	2275	Feb. 13, 1877	55 00
25,139	Daniel McLean	2280	Feb. 13, 1877	35 00
33,874	James D. Jones	2356	Feb. 22, 1877	105 89
42,777	Jacob B. Braden, estate of	2401	Mar. 7, 1877	1,004 13
23,390	Benjamin F. Brown	2417	Mar. 7, 1877	186 00
40,979	Anthony Teetes	2430	Mar. 8, 1877	4 00
40,586	Ira Lovelace, administrator of John Knox	3544	Apr. 18, 1877	300 00
32,823	McClure & Buck	3738	May 7, 1877	49 00
42,187	Baltimore and Ohio Railroad Company, (in part)	3767	May 11, 1877	15 40
26,872	Mrs. Jane Hale	3861	May 29, 1877	36 00
43,658	John A. Lynch	3872	May 31, 1877	45 00
38,326	John N. Bauer	3900	June 4, 1877	4 07
39,673	Richard B. Posey	3945	June 5, 1877	251 04
32,399	Matt Seats	3950	June 5, 1877	4 00
36,060	Jacob Dietz	4013	June 7, 1877	159 17
19,628	William and Robert Gilmor, ($91 92 paid by requisition of June 14, 1877)	6038	Apr. 19, 1875	4,358 08
35,848	William Hetch	3860	May 29, 1877	193 75
42,109	John Hazelrigg, trustee, &c	4095	June 19, 1877	450 00

Schedule of claims, &c.—Barracks, &c., 1871 *and prior years*—Continued.

No. of claim.	Claimant.	No. of sett.	Date.	Amount.
29,635	W. F. Camden	4454	Aug. 22, 1877	$12 50
35,597	Marion County, Missouri	4463	Aug. 22, 1877	2,280 00
18,308	Hamilton G. Fant	4501	Sept. 3, 1877	1,839 84
26,896	Bank of Kentucky	4495	Sept. 1, 1877	3,346 67
24,965	Wakefield & Son, (Q. M. D., $7 35; total allowed—incidental expenses, $23 14—$46)	4498	Sept. 1, 1877	15 51
12,228	Brooke Mackall, jr	4533	Sept. 8, 1877	2,748 94
23,801	Etmer, Foust & Co	4807	Nov. 10, 1877	54 00
35,771	Joseph Trimble, (in lieu of settlement 3039 of Dec. 1874; cancelled by Second Comptroller Nov. 9, 1877	4897	Nov. 20, 1877	1,200 00
9,408	Joseph Rolette, deceased; Mrs. A. Rolette, administratrix	4896	Nov. 20, 1877	141 67
42,262	City of Memphis	4980	Nov. 26, 1877	9,358 99
28,885	Wm. K. Griffith	4964	Nov. 27, 1877	100 00
29,146	J. W. Sprung and J. H. Eggers	4998	Nov. 28, 1877	60 00
40,439 40,440	R. C. Smith	4999	Nov. 28, 1877	30 00
44,635	S. Benedict, deceased, $17 under Q. M. D.; J. S. Cunningham, administrator)	5192	Dec. 20, 1877	231 92
	Total			33,460 56

INCIDENTAL EXPENSES, QUARTERMASTER'S DIVISION.—(Deficiency, $7,996 76; reappropriation, $477 49.)

42,155	J. N. Ransom and one other	1975	Dec. 28, 1876	$180 00
42,461	Wm. McKinstry	2033	Jan. 12, 1877	45 00
42,154	Charles E. Richards and one other	2067	Jan. 15, 1877	283 33
42,148	Isaac Cox	2069	Jan. 16, 1877	105 00
42,151	John H. Weldon	2073	Jan. 16, 1877	108 34
42,434	B. F. Ferguson	2085	Jan. 16, 1877	22 34
42,150	D. H. Smith	2088	Jan. 16, 1877	8 33
42,156	F. W. Young and one other	2090	Jan. 16, 1877	176 00
42,147	Conrad Bollinger	2092	Jan. 17, 1877	112 50
42,152	Joseph Johnson	2096	Jan. 17, 1877	108 33
42,158	R. S. Hernwag and eight others	2099	Jan. 17, 1877	147 00
42,157	O. M. Smith and one other	2100	Jan. 17, 1877	178 67
42,488	Charles Conner and one other	2109	Jan. 18, 1877	29 00
42,028	William Crane and one other	2093	Jan. 17, 1877	30 00
40,687	Western Union Telegraph Company, (in part)	2235	Feb. 5, 1877	147 22
40,620	John O'Ryan and one other	2276	Feb. 13, 1877	90 00
42,784	Olonzo Hedge	2296	Feb. 14, 1877	26 60
40,805	August Gruhlke	2320	Feb. 16, 1877	64 50
42,315	M. Bloomfield and thirteen others	2371	Feb. 24, 1877	714 62
40,837	Union Pacific Railroad Company	2172	Jan. 24, 1877	1,414 08
40,837	Central Pacific Railroad Company	2172	Jan. 24, 1877	1 19
40,687	Kansas Pacific Railway Company	2235	Feb. 5, 1877	452 03
40,211	Eliza C. Getty, widow of Vernon Getty	3851	May 29, 1877	*416 67
44,119	James Clarke	4011	June 7, 1877	62 50
40,761	Thomas H. Slatter and four others	4018	June 7, 1877	55 00
44,212	Harrison Wilson	4021	June 7, 1877	15 60
44,226	Union Pacific Railroad Company	4255	July 19, 1877	345 49
44,211	Union Pacific Railroad Company	4271	July 26, 1877	298 81
40,712	Hugh Frazer	4347	Aug. 8, 1877	433 33
44,144	Union Pacific Railroad Company	4422	Aug. 16, 1877	271 37
44,218	Union Pacific Railroad Company	4610	Oct. 8, 1877	830 52

* Coin.

Schedule of claims, &c.—Incidental expenses, Q. M. Div,—Continued.

No. of claim.	Claimant.	No. of sett.	Date.	Amount.
44,923	Fred. Sturuegk	4700	Oct. 15, 1877	$119 70
44,386	Western Union Telegraph Company	4782	Nov. 3, 1877	14 78
	Kansas Pacific Railroad Company, (payment one-half, $18, to Western Union Telegraph Company)			35 99
44,196	Union Pacific Railroad Company	4788	Nov. 8, 1877	1,011 24
44,316	Thomas M. De Lonza	4840	Nov. 13, 1877	119 17
	Total			8,474 25

HORSES FOR CAVALRY AND ARTILLERY, 1871 AND PRIOR YEARS.—(Deficiency, $9,902 86; reappropriation, $395.)

42,297	Sarah A. Ackerman, administratrix	1970	Dec. 28, 1876	$7 86
42,104	H. B. Guthrie, (in part)	2101	Jan. 17, 1877	200 00
33,308	Johanna Frost	2113	Jan. 18, 1877	150 00
40,073	John Hertel	2086	Jan. 16, 1877	165 00
42,782	John J. Edens	2298	Feb. 14, 1877	150 00
40,307	Sarah P. Lee	2300	Feb. 14, 1877	155 00
42,087	Emily T. Jackson, executrix, &c	2310	Feb. 15, 1877	130 00
33,641	John W. McLeroy	2422	Mar. 8, 1877	150 00
39,928	Wm. Robertson	2428	Mar. 8, 1877	150 00
43,592	William Hogan	3507	Apr. 16, 1877	120 00
40,071	Michael Letterer, (Lederer)	3523	Apr. 17, 1877	165 00
44,007	J. J. Osborne	3667	May 2, 1877	112 00
41,071	Mrs. Fannie Harding, (in part)	3706	May 4, 1877	260 00
44,048	A. P. Early	3732	May 7, 1877	80 00
42,082	Lewis Warren	3737	May 7, 1877	155 00
42,323	Allen Howard	3862	May 29, 1877	120 00
38,174	Mrs. Nancy Butler, (in part)	3898	June 4, 1877	135 00
44,109	Cord Myer	3938	June 5, 1877	150 00
43,996	Claus Steavens	3951	June 5, 1877	125 00
39,201	John Vance	3956	June 5, 1877	300 00
44,108	Claus Cordes	3964	June 5, 1877	130 00
20,001	Wm. H. Hughson	4032	June 9, 1877	115 00
38,276	Marion Minton	4036	June 9, 1877	145 00
44,201	Rich'd W. Jordon, deceased	4063	June 13, 1877	125 00
44,002	Diedrick Lutzen	4097	June 19, 1877	160 00
39,400	Wm. Floyd	4348	Aug. 8, 1877	300 00
40,871	Henry Dobbins	4343	Aug. 8, 1877	75 00
44,412	Adam Nolte	4364	Aug. 9, 1877	100 00
42,040	Mrs. Myra Cook, (formerly Montague)	4363	Aug. 9, 1877	165 00
34,296	H. C. Hamilton	4457	Aug. 22, 1877	155 00
42,353	G. Harding	4459	Aug. 22, 1877	150 00
32,785	Joel McKinney	4532	Sept. 8, 1877	90 00
44,647	Robert Latimer	4632	Oct. 9, 1877	160 00
44,665	Benjamin P. Dobson	4644	Oct. 9, 1877	150 00
32,763	Jonathan Rucker	4641	Oct. 9, 1877	140 00
29,781	R. B. Douglas	4646	Oct. 9, 1877	450 00
44,799	J. W. Holoway	4630	Oct. 9, 1877	160 00
23,752	Woodruff Parks	4576	Sept. 22, 1877	100 00
40,662	John Ficken	4667	Oct. 12, 1877	80 00
45,072	Chas. W. Tenant	4817	Nov. 10, 1877	150 00
45,074	R. H. Jones	4811	Nov. 10, 1877	120 00
25,229	D. G. Christian	4806	Nov. 10, 1877	240 00
16,983	Volney Goodhue, deceased, by Jas. Haggard, administrator	4847	Nov. 13, 1877	100 00
45,120	Thomas P. Yates	4863	Nov. 13, 1877	125 00
38,065	Thomas H. Bell	4831	Nov. 13, 1877	60 00
39,803	Mrs. Ann Eliza Powell	4856	Nov. 13, 1877	80 00

Schedule of claims, &c.—Horses, &c., 1871 *and prior years*—Continued.

No. of claim.	Claimant.	No. of sett.	Date.	Amount.
29,776 / 29,778	Mrs. Marina Douglas, ($60, under A. T., 1871.)	4935	Nov. 26, 1877	$130 00
44,814	John A. Patterson	4941	Nov. 26, 1877	148 00
29,766	Gideon Gifford	4937	Nov. 26, 1877	125 00
45,342	Micajah Carter	4956	Nov. 27, 1877	160 00
42,317	James M. Adams	4924	Nov. 27, 1877	125 00
39,804	James A. Lucas	4977	Nov. 27, 1877	115 00
45,317	Mrs. C. W. Jackson	4973	Nov. 27, 1877	250 00
36,633	John Hedrick	4970	Nov. 27, 1877	200 00
29,785	A. H. Halbert	4966	Nov. 27, 1877	125 00
45,280	Thos. E. Mahon	4982	Nov. 28, 1877	70 00
26,609	William Woodson, ($152 33 under subsistence; $118 under Q. M. D.; total, $580 33)	5008	Nov. 28, 1877	310 00
29,736	Andrew Thompson	5001	Nov. 28, 1877	100 00
38,240	Larkin Willis, dec'd; W. R. Willis, adm'r.	5004	Nov. 28, 1877	90 00
39,278	John C. Magill, dec'd; Lydia A. Magill, administratrix	5002	Dec. 6, 1877	750 00
29,779	Mildred Chapman	5120	Dec. 17, 1877	100 00
29,780	A. J. Swaney	5179	Dec. 19, 1877	150 00
29,771	Wm. Wilson	5183	Dec. 19, 1877	125 00
43,969	Mrs. Mary E. Wormeley	5185	Dec. 19, 1877	135 00
45,394	Geo. W. Allen	5198	Dec. 21, 1877	150 00
24,408	Jno. R. Frow, deceased	5206	Dec. 21, 1877	135 00
	Total			10,297 86

NATIONAL CEMETERIES, 1871 AND PRIOR YEARS.—(Deficiency, $181 36; reappropriation, $2 49.)

18,941	Wm. J. Marshall, exec'r, *et al.*, (part paid)	9444	June 16, 1874	$120 00
38,188	A. Jarreau	6862	June 19, 1875	18 85
40,251	J. H. Van Hage	9151	April 13, 1876	45 00
	Total			183 85

NATIONAL CEMETERIES, 1872.—(Deficiency.)

26,653	James S. Fish	1671	Sept. 8, 1874	$40 00
39,821	Chronicle Publishing Company, (in part)	8546	Jan. 13, 1876	36 00
	Total			76 00

NATIONAL CEMETERIES, 1875.—(Deficiency.)

44,790	J. H. Wilkerson	4670	Oct. 12, 1877	$18 00

HORSES AND OTHER PROPERTY LOST IN THE MILITARY SERVICE—ACT OF MARCH 3, 1849—*Steamers and other vessels.*—(Deficiency.)

372	Steamer B. P. Cheney, Charles Latimer, owner	4107	June 21, 1877	$28,370 72
133	G. C. Crumbaugh, administrator of J. W. Wills, value of a barge	5121	Dec. 17, 1877	400 00
	Total			28,770 72

Schedule of claims, &c.—Continued.

HORSES AND OTHER PROPERTY.

Name of claimant.	Amount allowed.	No. of sett.	Remarks.
Sam'l K. Vaughan	$127 00	3464	
Sarah S. Madison	100 00	3574	
Adolph Ziperline	200 00	3777	
H. Von Minden	145 03	3868	
Rob't B. Jordan	120 00	3897	
Jno. W. Sidwell	193 03	4041	
Wm. Ashmead	115 00	4187	
Wm. E. Fay	191 53	4201	
Margaret Marshall	100 00	4425	
S. C. Hodgman	172 00	4485	
J. S. Dolson	175 00	4637	
Benj. McCluer	100 00	4644	
Henry Jackson	173 43	4651	
Christian Pickell	65 18	4765	Father of claimant.
T. Edgar Park	115 00	4799	
C. B. Goodwin	142 78	4883	
Thomas Caborn	150 00	4921	
Columbus Moore	160 00	4972	
H. N. Whitbeck	150 00	4978	
Henry F. Sapp	100 00	4997	
Geo. W. Moore	100 46	4999	
Ezra Fitch	100 00	5008	
Zach H. Hall	127 40	5009	
David R. Chumley	128 10	5010	
John Devany	92 85	5011	
Eliza Conden	177 06	5012	
Edward P. Dawson	175 00	5013	
Henry T. Jones	125 00	5014	
John Gordon	150 00	5015	
Joseph R. Ward	74 93	5016	
J. C. Bleck	75 00	5017	
Louis T. Crain	135 00	5018	
Elsey W. Lewis	170 00	5019	
James C. Harris	120 00	5020	
John A. Nobletts	95 68	5021	
Noah Castor	146 80	5022	
Ellen M. Misner	50 00	5023	
Elijah Pike	115 18	5024	
Simeon D. Swan	200 00	5025	
John A. Clark	176 43	5026	
Nathaniel McCalla	150 00	5027	
Nathaniel McCalla	140 00	5028	
Richard E. Oliver	125 00	5029	
James Watson	102 06	5030	
Harrison P. McBee	134 25	5031	
Absalom McKinney	151 50	5032	
James W. Conley	90 00	5033	
C. W. Warren	180 22	5034	
E. C. Leadyard	150 00	5035	
E. C. Ledyard	200 00	5036	
Daniel Mathew	109 00	5037	
Jonathan E. Stoffer	253 50	5038	
Scott W. Harrington	200 00	5039	
Fielding Hurt	200 00	5040	
William Huff	125 00	5041	
J. L. Paxon	160 00	5042	
Otis E. French	152 00	5043	
Otis E. French	200 00	5044	
Harmon D. Hunt	125 00	5045	

Schedule of claims, &c.—Horses and other property—Continued.

Name of claimant.	Amount allowed.	No. of sett.	Remarks.
D. C. McKillip	$110 00	5046	
James M. Zumwalt	75 00	5047	
Louisa George	125 00	5048	Jno. B. Bannett.
Wm. S. Coleman	125 00	5049	
Wm. C. Human	100 00	5050	
Bloomfield Logan	80 00	5051	
Le Roy Hatley	125 00	5052	
A. F. Jones	125 00	5053	
Emeline Lunsford	87 78	5054	Widow of J. C. Watson
Emeline Lunsford	122 78	5055	Widow of J. C. Watson
John Conger	163 25	5056	
William Hill	125 00	5057	
William Hill	130 00	5058	
Chas. F. Ferguson	85 00	5059	
Chas. F. Ferguson	100 00	5060	
Callom McIntosh	90 00	5061	
Chas. S. Parish	200 00	5062	
Sam'l Brockmire	100 00	5063	
Joseph M. Jones	85 00	5064	
John B. Lee	135 00	5065	
John B. Lee	150 00	5066	
John F. Cullip	125 00	5067	
John F. Cullip	145 03	5068	
George Glenn	367 00	5069	
Wm. H. Rolls	195 00	5070	
Isaac M. C. Hays	177 06	5071	
Martin McCune	100 00	5072	
James T. Parshall	176 10	5073	
James H. Layton	152 06	5074	
Harrison Hughes	70 00	5075	
Beal S. Ijams	100 00	5076	
L. J. Dillon	125 00	5077	
Edward B. Huffman	100 00	5078	
D. R. Downing	93 18	5079	
W. C. Human	185 00	5080	
Jacob Casto	75 00	5081	
S. L. Beaver	100 00	5082	
Rob't A. Numnelly	125 00	5083	
Wm. M. Mitchell	100 00	5084	
Jno. W. Leathers	130 00	5085	
Wm. M. Smalley	175 00	5086	
D. C. Nelson	107 06	5087	
J. Bardgett	127 06	5088	
Elias Chapman	110 03	5089	
Daniel H. Groves	102 43	5090	
Sam'l D. Haight	150 00	5091	
Sam'l D. Haight	175 00	5092	
Chas. W. Burris	120 00	5093	
Fountain Thomas	125 00	5094	
Fountain Thomas	120 00	5095	
Richard G. Large	140 00	5096	
Jasper C. Avery	140 00	5097	
Jno. S. Baker	122 88	5098	
Albert June	70 00	5099	
A. J. Willetts	99 78	5100	
E. S. Carroll	162 78	5101	
L. C. Houk	200 00	5102	
Wm. C. Pinkley	125 00	5103	
Andrew Reinert	115 00	5104	
Joseph Gehasky	96 00	5105	
Martha A. Dever	166 43	5106	

Schedule of claims, &c.—Horses and other property—Continued.

Name of claimant.	Amount allowed.	No. of sett.	Remarks.
Sam'l M. Tinker	$90 00	5107	
Joseph Tulfer	153 91	5108	
Wm. H. Scott	85 00	5109	
E. M. Church	90 00	5110	
David Baker	140 00	5111	
David Baker	155 03	5112	
H. M. Deeds	158 95	5113	
Joseph Montray	60 00	5114	
W. L. Weeden	75 00	5115	
W. H. Foy	131 15	5116	
Susan Churchill	177 78	5117	
M. Y. Eagye	142 18	5118	
J. J. Hall	150 00	5119	
Brazillia P. Stacey	200 00	5120	
B. W. Searle	120 00	5121	
Andrew J. Berry	127 06	5122	
James H. Bond	107 78	5123	
John H. Foster	102 78	5124	
Wm. R. Cook	185 00	5125	
Joseph Eggers	80 00	5126	
Benj. D. Fearing	100 00	5127	
Laton Glover	130 00	5128	
L. P. Hay	135 00	5129	
Wm. Standiford	85 00	5130	
George W. Stewart	131 43	5131	
John S. Mowry	150 00	5132	
J. A. Collins	130 00	5133	
J. A. Collins	125 00	5134	
Wm. P. Innes	200 00	5135	
Wm. P. Innes	175 00	5136	
Jno. H. Mills	82 78	5137	
E. T. Denny	80 00	5138	
Homer C. Reed	165 00	5139	
Homer C. Reed	200 00	5140	
W. C. Hopper	47 00	5141	
John Zier	131 75	5142	
Isaac Winner	175 74	5143	
Joel B. McGregor	105 00	5144	
Marshall P. Thatcher	150 00	5144½	
James D. Thompson	75 00	5145	
Cyrus Carter	90 00	5146	
James P. Halett	40 00	5147	
S. G. Clark	200 00	5148	
S. G. Clark	125 03	5149	
E. G. Rhea	140 00	5150	
J. K. & G. R. Hines	1,500 00	5151	
Andrew C. Shepherd	255 56	5152	
John E. Frank	90 00	5153	
James A. Goforth	29 59	5154	
Oliver Vincent	130 46	5155	
T. A. Sarasin	55 00	5156	
D. McWilliams	145 00	5157	
A. Adams	85 00	5158	
J. M. Coe	125 00	5159	
J. M. De Friese	174 78	5160	
J. M. De Friese	150 00	5161	
D. M. Sprague	169 25	5162	
J. S. Street	150 00	5163	
Joseph McCoy	251 00	5164	
John McLean	100 00	5165	
Philip W. Cox	175 00	5166	

Schedule of claims, &c.—Horses and other property—Continued.

Name of claimant.	Amount allowed.	No. of sett.	Remarks.
Salem Padgett	$90 00	5167	
J. P. Johnson	150 00	5168	
Joseph Stanley	30 63	5169	
Joseph Stanley	80 00	5170	
Joseph Stanley	130 63	5171	
Claus Cords	70 00	5172	
Caleb Bunn	100 00	5173	
J. Reitz	120 00	5174	
Maria L. Yost, (administratrix)	197 78	5175	T. H. Smith.
David Ross	135 00	5176	
Morton A. Pratt	132 78	5177	
Morton A. Pratt	100 00	5178	
Henry Scates	33 00	5179	
John Wickeser	135 00	5180	
John Wickeser	120 00	5181	
James J. Davis	150 50	5182	
James T. Turner	115 00	5183	
Samuel Keller	153 53	5184	
Ira Pogue	74 50	5185	
A. B. Rowden	141 88	5186	
Pollard Appleby	125 00	5187	
Philip Fann	125 00	5188	
Charles Starkey	100 00	5189	
Claus Stephens	60 00	5190	
Henry Sisk	100 00	5191	
J. T. Thomas	80 00	5192	
J. T. Thomas	127 06	5193	
J. D. Melton	140 00	5194	
H. E. Warren	100 00	5195	
James Downing	80 00	5196	
John Humphreys	75 00	5197	
Hiram Reagan	100 00	5198	
M. V. Teems	100 43	5199	
Samuel J. Tarver	120 00	5200	
G. P. Clevenger	144 25	5201	
W. D. Van Norman	85 00	5202	
D. H. Dunbar	150 00	5203	
A. B Filsom	90 00	5204	
James F. Gaylard	135 00	5205	
James B. Harper	125 00	5206	
George Million	90 00	5207	
Charles A. Steinerd	143 93	5208	
Hosea Springer	141 60	5209	
Hosea Springer	115 00	5210	
Nathan Akins	68 00	5211	
F. W. Dyer	148 18	5212	
Asa C. Hamm	147 00	5213	
Isaac M. Lusk	150 00	5214	
J. A. Craft	171 43	5215	
J. C. Abney	125 00	5216	
John Evans	75 00	5217	
D. P. Simmons	50 00	5218	
Samuel Gilbert	200 00	5219	
Samuel Gilbert	200 00	5220	
Henry E. Snow	200 00	5221	
H. L. Averill	113 75	5222	
W. O. Camp	150 00	5223	
H. D. Roe	174 05	5 24	
Benj. Mills	150 00	5225	
Joseph Ozenberger	75 00	5226	
Henry V. Stall	169 25	5227	

Schedule of claims, &c.—Horses and other property—Continued.

Name of claimant.	Amount allowed.	No. of sett.	Remarks.
E. R. Brink	$150 03	5228	
E. R. Brink	170 03	5229	
Robert M. McReynolds	85 00	5230	
P. K. Parsons	200 00	5231	
Moore Richmond	137 50	5232	
W. W. Higgins	55 00	5233	
L. E. Irwin	100 00	5234	
A. Woodcock	90 00	5235	
Sarah Cooley	135 00	5236	
S. R. Givin	120 00	5237	
Gerrett S. Humphreys	110 00	5238	
John M. Reynolds	105 00	5239	
J. F. Thresher	65 00	5240	
James A. Umpleby	160 00	5241	
Wm. L. Farrow	150 00	5242	
Benoni Mills	137 18	5243	
J. F. Brown	152 20	5244	
Fred. Slate	122 78	5245	
W. W. Foster	165 00	5246	
A. J. Foster	122 78	5247	
A. J. Foster	40 00	5248	
W. J. Day	154 68	5249	
J. W. Lucas	146 18	5250	
P. C. Meyer	115 00	5251	
Geo. M. Mark	151 25	5252	
James C. Long	124 81	5253	
J. W. Horn	234 00	5254	
J. W. Horn	200 00	5255	
W. C. Moegling	177 88	5256	
Nancy Delany	121 78	5257	
Edward Hatfield	80 00	5258	
J. W. Herrington	122 78	5259	
Wm. N. Wells	115 00	5260	
M. M. Barnhart	48 68	5261	
James Martin	173 43	5262	
W. E. Wilson	150 00	5263	
B. T. Waldrix	90 00	5264	
S. B. Marks	90 00	5265	
Wm. E. Yowell	170 83	5266	
J. S. Donham	100 00	5267	
F. Pharis	125 00	5268	
F. Pharis	90 00	5269	
J. B. Williams	260 98	5270	
Geo. L. Bone	100 00	5271	
B. F. Morgan	75 00	5272	
F. Leber	125 00	5273	
F. Leber	30 00	5274	
J. B. Newsome	100 00	5275	
James E. Colville	130 00	5276	
B. F. Crocker	135 00	5277	
Fred. Putzer	114 00	5278	
John Gilbert	155 83	5279	
Richard M. Hayes	171 18	5280	
Rob't McDaniels	125 00	5281	
David Rush	138 18	5282	
J. F. Kent	144 18	5283	
Mrs. M. J. Snibley	78 00	5284	
W. R. Cook	173 43	5285	
W. D. Higgins	178 50	5286	
Cord Meyers	100 00	5287	
J. W. Sheets, (lieut. col.)	281 28	5288	

Schedule of claims, &c.—Horses and other property—Continued.

Name of claimant.	Amount allowed.	No. of sett.	Remarks.
Rob't Johnson	$125 00	5289	
H. Bryant	70 00	5290	
H. Bryant	70 00	5291	
Jno. Berry	122 85	5292	
N. T. Casey	75 00	5293	
M. Thacker	110 00	5294	
Jasper Coats	100 00	5295	
J. W. Freeman	220 00	5296	
J. K. Lones	150 03	5297	
Fred. Joindt	166 43	5298	
Benj. J. Routh	95 00	5299	
Thos. J. Wilson	85 00	5300	
J. W. C. Brown	171 00	5301	
J. W. C. Brown	160 00	5302	
Jno. M. Basket	120 00	5303	
Thos. F. Hare	85 03	5304	
D. M. Claggett	130 06	5305	
J. F. Owen	150 00	5306	
John H. Howe	175 00	5307	
Wm. McMurtry	125 00	5308	
Overton Mayes	150 00	5309	
Timothy Minton	125 00	5310	
Joel Rushing	167 06	5311	
G. W. McDaniel	165 00	5312	
A. Z. Gray	200 00	5313	
Rob't G. Smithers	140 00	5314	
W. B. Chapman	85 00	5315	
D. A. Higgins	40 00	5316	
J. G. Lanhorn	125 00	5317	
John Whittington	75 00	5318	
J. W. Echols	130 00	5319	
D. C. Jennings	125 00	5320	
W. R. Cohoon	71 18	5321	
Chas. A. Johnson	200 00	5322	
John A. Clark	176 78	5323	
James J. McConnell	135 68	5324	
S. S. McFadden	110 00	5325	
Jannett Taylor	147 78	5326	
Wm. M. Lee	150 18	5327	
Thos. McGregor	100 00	5328	
R. B. Ellis	120 00	5329	
James V. Powell	100 00	5330	
R. H. Vandike	182 00	5331	
Amos Nichols	122 00	5332	
Fletcher M. Welpton	125 00	5333	
Francis M. Pitts	102 00	5334	
	46,515 66		
To which add claim of Thomas M. Davis, reaffirmed by the Second Comptroller January 5, 1878	135 00	4711	
Total	46,650 66		
Steamers and other vessels	$28,770 72		
Horses and other property	46,650 66		
Total	75,421 38		

Schedule of claims, &c.—Continued.

COMMUTATION OF RATIONS TO UNION PRISONERS OF WAR—Joint Resolution, July 25, 1866, 14 Stat., 364.—(Deficiency.)

No. of claim.	Claimant.	No. of sett.	Date.	Amount.
45,455	Henry W. Rhinehart	2514	Dec. 14, 1877	$37 75
45,457	William West	2515	Dec. 14, 1877	21 00
45,456	Peter Wendel	2516	Dec. 14, 1877	5 00
45,459	Clement Williamson	2517	Dec. 14, 1877	6 50
45,460	Hamilton White	2518	Dec. 14, 1877	7 25
45,458	Alvin T. Withers	2519	Dec. 14, 1877	27 75
45,435	David Harrington	2520	Dec. 14, 1877	74 50
45,437	Julius E. Hamby	2521	Dec. 14, 1877	6 25
45,440	Samuel Heineken	2522	Dec. 14, 1877	6 75
45,436	James J. Hall	2523	Dec. 14, 1877	32 75
45,438	John W. Hanselman	2524	Dec. 14, 1877	29 75
45,422	Theo. T. Brummet	2525	Dec. 14, 1877	14 75
45,420	John T. Beebee	2526	Dec. 14, 1877	26 50
45,419	Aucil Brandenburg	2527	Dec. 14, 1877	3 25
45,421	David Beightler	2528	Dec. 14, 1877	2 75
45,423	William W. Burnett	2529	Dec. 14, 1877	11 00
45,417	James H. Bainum	2530	Dec. 14, 1877	6 25
45,418	Thomas Q. Blair	2531	Dec. 14, 1877	139 50
45,432	Jacob Pfortner	2532	Dec. 14, 1877	5 00
45,451	Otis D. Morehead	2533	Dec. 14, 1877	17 50
45,454	James P. McGahey	2534	Dec. 14, 1877	7 00
45,453	Daniel McCollum	2535	Dec. 14, 1877	3 50
45,452	John Moore	2536	Dec. 14, 1877	55 25
45,449	Martin Mauger	2537	Dec. 14, 1877	5 50
	(No. 2538 is not one of this class.)			
45,450	John C. Marshall	2539	Dec. 14, 1877	2 25
45,446	George W. Lewis	2540	Dec. 15, 1877	8 75
45,445	Phaon Laury	2541	Dec. 15, 1877	21 00
45,448	Gamaliel J. Lund	2542	Dec. 15, 1877	18 75
45,447	Peter Lloyd	2543	Dec. 15, 1877	103 75
45,444	Peter Kremer	2544	Dec. 15, 1877	9 25
45,443	Theo. Keller	2545	Dec. 15, 1877	21 00
45,416	Robert B. Armstrong	2546	Dec. 15, 1877	48 25
45,429	Robert T. Cooper	2547	Dec. 15, 1877	5 25
45,426	Alex. C. Carman	2548	Dec. 15, 1877	37 00
45,427	Thomas M. Christian	2549	Dec. 15, 1877	75 50
45,428	Moses Coffey	2550	Dec. 15, 1877	17 50
45,442	George Hudson	2551	Dec. 15, 1877	4 50
45,441	Joseph Hough	2552	Dec. 15, 1877	30 75
45,434	Jesse Grubb	2553	Dec. 15, 1877	56 00
45,433	Brisco Goodhart	2554	Dec. 15, 1877	39 00
45,425	William H. Carpenter	2555	Dec. 15, 1877	7 75
45,424	Fred. W. Cady	2556	Dec. 15, 1877	11 00
45,430	Martin V. Day	2557	Dec. 15, 1877	95 00
45,431	Gideon P. Doughman	2558	Dec. 15, 1877	10 25
45,135	John W. Doughty, deceased, (Edward Doughty's father)	2596	Dec. 17, 1877	76 25
45,439	Samuel C. Haines	2598	Dec. 18, 1877	30 75
45,641	Benjamin Price	2640	Dec. 22, 1877	17 50
45,647	Silas B. Harrington, deceased	2641	Dec. 22, 1877	48 75
	Total			1,348 75

ORDNANCE SERVICE, 1871 AND PRIOR YEARS.—(Deficiency.)

Certified by accounting officers:
Thomas Slevin, hauling pig-iron $102 75

Schedule of claims, &c.—Continued.

RELIEF OF CERTAIN MUSICIANS AND SOLDIERS FOR LOSSES AT FORT SUMTER IN 1861—Act of July 24, 1861.—(Deficiency.)

Certified by accounting officers:	
Edmund Walsh, late private, Company "H," 4th Artillery...........	$15 00

($194 carried to the surplus fund June 29, 1872.)

APPENDIX L.

Explanation of the estimates of the Commissioner of Patents. (*See page* 16.)

DEPARTMENT OF THE INTERIOR,
United States Patent Office, Washington, D. C., October 9, 1877.

SIR: * * * I have asked for an additional appropriation of $43,600 for the contingent and miscellaneous expenses of the office for the current fiscal year. This is not in the nature of a deficiency, but to meet the extraordinary expenses resulting from damages by fire and water. I have itemized the purposes, and carefully estimated the amounts required for each outlay. I find that I can relieve to some extent the already over-crowded cases in the east and south hall, and provide for a time for the accruing models, by constructing a platform and second tier of cases on the south side of the F-street hall, similar to that upon the north side. For this I have estimated the cost of the latter $12,000.

It having been determined to remove from the attics of this building, the drawings and specifications now stored there, amounting to several tons, I have estimated that $4,000 will be required to fit up rooms and shelving, and remove and rearrange them in new cases.

The awnings were all destroyed at the time of the fire, some furniture, and many valuable drawing-instruments in use by tracers occupying alcoves in the burnt portion of the model-room were abandoned and destroyed. The furniture and carpets, by repeated hasty removals and drenchings, have become very much damaged and defaced, and extensive repairs are necessary. I have estimated the immediate expense at $10,000.

To carpet and furnish the rooms in the Wright building, occupied by the copying and tracing divisions of this office, will require $600.

To restore and classify such metal models as were damaged but not destroyed by fire, heretofore mentioned, by skilled workmen, I estimate will cost $5,000.

Much expense has been, and more will probably be, incurred for labor, material, &c., in temporarily protecting the property of the office from damage by fire, the water thrown into the building to extinguish it, and subsequent storms. This is an extraordinary demand upon the present contingent fund of the office. I have estimated it at $2,000, and asked its reimbursement.

By reason of the loss and damage to models and drawings, and the derangement of models, drawings, files, and specifications, an additional clerical and laboring force will be necessary to rearrange them, and obtain necessary information for the use of the examining corps in the

current work of the office, and for responses to letters of inquiry. I have estimated the additional expense for this purpose for the present fiscal year at $10,000.

By careful survey and actual estimate it is found that upwards of $6,000,000 copies of drawings and back issues of patents have been destroyed or so defaced that reproduction is necessary. To reproduce these it will cost, at the rate paid for photo-lithographic drawings of current issues, $60,000. I believe that three-fourths of these can be reproduced during the present fiscal year, and have asked for an appropriation of $45,000 for this purpose. The balance ($15,000) is included in the estimate for the next fiscal year under the head of photo-lithographing current and back work.

For photo-lithographing current issues I have asked for $15,000 to meet a deficiency in the appropriation for this purpose for the current fiscal year. It has been impossible to secure a contract for the prompt and satisfactory execution of this work at a cost less than an aggregate of $40,000 per annum.

For the "Official Gazette" I have also been obliged to ask for an appropriation of $15,000, to cover a deficiency in the appropriation for this work for the current year. I have explained, in referring to my estimates for the ensuing fiscal year, that the cost of the illustrated portion of the paper is $19,000 per annum and upwards, and the expense for employés is as much more.

Very respectfully, your obedient servant,

ELLIS SPEAR,
Commissioner of Patents.

Hon. SECRETARY OF THE INTERIOR.

APPENDIX M.

Explanation of estimates for Columbia Institution for the Deaf and Dumb. (*See page* 19.)

COLUMBIA INSTITUTION FOR THE DEAF AND DUMB,
April 26, 1877.

SIR: Acknowledging the receipt of your esteemed favor of the 17th instant, I have the honor to forward herewith estimates of appropriations for the service of this institution for the fiscal year ending June 30, 1878.

The amounts submitted were included in our estimates of September 19, 1876, designed to provide for the next fiscal year, but were not appropriated at the last session of Congress.

The likelihood of our needing the amount asked to be added for the support of the institution, viz., $3,000, is now much greater than when it was originally asked for last September, for the reason that the estimate for the completion of our buildings was favorably acted upon by Congress.

We expect our College building to be ready for occupancy in October next, and we have every reason to believe that the number of our pupils will be much increased over that of the current year. To provide for this increase, and for the proper care, warming, and lighting

of the new building, we shall be sure to require the full amount estimated for, last September.

The need for the appropriation for the enclosure, improvement, and care of our grounds, is more pressing than when the estimate was first submitted. No appropriation for this object has been made for several years, and many portions of our fences are in so dilapidated a condition as to be at the mercy of every high wind. Tramps and marauders break through these old fences with ease, and we find it impossible to give even the appearance of protection to the grounds at many points.

The front line of our grounds has been so interfered with by the grading and curbing of Boundary street as to present a very discreditable appearance, for the remedy of which we have no funds at our command.

The completion of our buildings will necessitate a considerable amount of grading of roads and walks to provide suitable approaches, and it is very important to the health of the institution that we should extend and improve our system of drainage.

The amount now submitted as an estimate will not be sufficient to *complete* all the improvements that are important for the final arrangement and proper enclosure of our grounds; it is, however, as much as we ought, perhaps, to ask in a single year.

With a view of very greatly reducing the ultimate expense of enclosing our grounds, which should have a strong iron railing at least along the line on Boundary street, I venture to suggest that the railing around Lafayette square might be turned over to the institution, the expense of removal being met out of the appropriation now asked for. So high and heavy a railing is of no possible importance where it stands, and, as a matter of taste, would be condemned by any competent landscape architect, while, as a part of the permanent enclosure of the premises of this institution, its full value would be realized. I would, therefore, respectfully urge that Congress be asked to authorize its transfer to this institution.

I have the honor to be, very respectfully, your obedient servant,

E. M. GALLAUDET,
President, &c.

Hon. SECRETARY OF THE INTERIOR.

COLUMBIA INSTITUTION FOR THE DEAF AND DUMB,
August 28, 1877.

SIR:

* * * * * * *

I also submit an estimate of five thousand dollars for the fitting up and furnishing of the buildings of the institution, [but two thousand five hundred dollars is submitted in the estimate, as a like amount was appropriated for this object in the deficiency act of December 15, 1877,] which I have placed on a deficiency blank, and request that it may be inserted among the estimates asked to be appropriated for the service of the current fiscal year.

The need for this appropriation grows out of the probable completion and occupancy of our College building by the first of November next, much new furniture and many fixtures of a more or less permanent character being necessary for the proper accommodation of those who will occupy the new building.

I beg leave to call attention to estimates submitted under date of April 26, 1877, which I have not repeated, but which are needed for the reasons set forth in my letter of the date just named.

I have the honor to be, very respectfully, your obedient servant,

E. M. GALLAUDET,
President, &c.

Hon. SECRETARY OF THE INTERIOR.

APPENDIX N.

Explanation of the estimate under the head of Geographical Survey of the Territories. (See page 23.)

DEPARTMENT OF THE INTERIOR,
U. S. Geographical and Geological Survey, Rocky Mountain Region,
Washington, D. C., August 24, 1877.

SIR: Under date of May 8, 1877, I received instructions from the Secretary of the Interior as follows:

"SIR: You are hereby notified that the lease of the building on the corner of Eighth and G streets, in this city, will terminate on the 31st instant, and that on said date this Department will quit possession of the same.

"Very respectfully,
"C. SCHURZ, *Secretary.*

"Major J. W. POWELL,
"*Office of the U. S. Geological and Geographical Survey of the Territories.*"

Since that time the materials of my office have been stored in the basement of the building known as the Patent-Office building, and four rooms in a private dwelling have been occupied as offices. These rooms were not rented by the Department, and no pledge has been made for the payment of the rent by the Government, as there was no authority of law therefor, and no appropriation from which it could be paid.

Heretofore the furniture used in the offices under my direction has been borrowed from other bureaus of the Intetior Department, and such furniture has been quite inadequate to the wants of my office, and finally it has been found necessary to return it.

It is believed these statements will fully explain the necessity for the estimate of $4,000, for office-rent and furniture, which I submit herewith.

I am, with great respect, your obedient servant,

J. W. POWELL.

Hon. SECRETARY OF THE INTERIOR,
Washington, D. C.

DEPARTMENT OF THE INTERIOR,
U. S. Geographical and Geological Survey, Rocky Mountain Region,
Washington, D. C., August 24, 1877.

SIR: In the summer of 1875, by direction of the Secretary of the Interior, a survey was made of the Black Hills of Dakota. This survey

was made by Mr. Walter P. Jenney, assisted by several scientific gentlemen, and a preliminary report was published early in 1876.

Mr. Henry Newton, the geologist, also prepared an elaborate and careful report on the geology of the district, and the geographers of the expedition prepared contour and hachure maps.

In the meantime Mr. Jenney and the geographic assistants had retired from the work, and the preparation of the final report was left to Mr. Henry Newton, the geologist. In May last, Mr. Newton received the following instructions:

"DEPARTMENT OF THE INTERIOR,
"*Washington, D. C., May* 26, 1877.

"SIR: I have the honor to acknowledge the receipt of your letter of the 23d instant, relative to the material prepared for your report on the geological and mineralogical examination of the Black Hills, made by yourself in connection with Professor W. P. Jenney, in the summer of 1875, in which you express a desire to turn over such material to Major J. W. Powell, in view of its publication in his report.

"Your letter and the accompanying papers, signed by a number of scientific gentlemen of your city, setting forth their views as to the value of your work, was referred to Major Powell, who reports that, from personal examination of the same, he deems it to be of great value. You will, therefore, deliver to Major Powell the reports, maps, and illustrations of your work in the Black Hills, in order that the public may, at an early day, have the advantage of your labors.

"Very respectfully, your obedient servant,
"C. SCHURZ, *Secretary.*

"Professor HENRY NEWTON,
"*New York.*"

The work having thus been placed under my charge, I have caused careful estimates to be made of the cost of engraving and printing the maps, and also of engraving and printing the geological plates, and it has resulted in the amount placed in the estimate which I submit herewith.

The report is one of very great value, and the survey has already cost the Government many thousands of dollars, and it is deemed wise to ask for the small appropriation of $4,840 to complete the work, and to give the results to the world.

I am, with great respect, your obedient servant,
J. W. POWELL.

HON. SECRETARY OF THE INTERIOR,
Washington, D. C.

APPENDIX O.

Explanation of estimates for Expenses of United States Courts and Support of Convicts. (*See page* 42.)

DEPARTMENT OF JUSTICE, *February* 13, 1878.

SIR: I have the honor to transmit herewith estimates of existing deficiencies in appropriations disbursed by this Department, with the request that you will lay them before Congress for its action.

There will be needed the sum of one hundred and ten thousand (110,000) dollars to pay unsettled accounts chargeable to the fund for paying the expenses of the United States courts for the fiscal year ending June 30, 1877.

There will be required the sum of eight thousand (8,000) dollars to supply a deficiency in the fund for transferring convicts from the District of Columbia, which is now exhausted.

The reasons for applying for these sums are set forth in the accompanying letter, dated this instant, and abstract of the First Comptroller of the Treasury, which are respectfully submitted.

Very respectfully,

CHARLES DEVENS,
Attorney General.

Hon. JOHN SHERMAN,
Secretary of the Treasury.

TREASURY DEPARTMENT,
First Comptroller's Office, February 12, 1878.

SIR: In answer to your letter of the 1st instant, I have the honor to state that in my opinion an appropriation of one hundred and ten thousand dollars ($110,000) will be required to pay the unsettled accounts of officers of United States courts and the miscellaneous claims which are chargeable to the judiciary fund of the fiscal year ending June 30, 1877. I transmit herewith an abstract of the accounts and claims of this description which are now before this Department. Others are coming in daily, and it is impossible to state the exact sum needed.

The abstract does not contain any of the accounts for which an appropriation was made on the 21st of November, 1877, and yet it amounts to $93,597 34.

There is a balance of $15,553 62 to the credit of the appropriation on the books of this Department, of which about $5,000 is available for the payment of the accounts included in the abstract. The residue is applicable to accounts previously received, which it has been impracticable to settle up to this date.

The appropriation for 1878 for support of convicts transferred from the District of Columbia is exhausted. It is estimated that at least eight thousand dollars will be required to supply the deficiency, and an appropriation of that sum is necessary.

I am not at present advised of any other deficiency of appropriation under your Department than those above mentioned.

Very respectfully,

R. W. TAYLER,
Comptroller.

Hon. CHARLES DEVENS,
Attorney General.

Abstract of unsettled accounts and claims before the Treasury Department, for expenses of United States Courts, in the year ending June 30, 1877.

Districts.	Attorneys.	Asst. attorneys.	Clerks.	Commissioners.	Rent.	Board of prisoners.	Miscellaneous.	Balances due to marshals.
Alabama, Northern						$1,181 13	$25 20	
Alabama, Middle			$22 60	$158 35		960 85		
Alabama, Southern							110 50	$736 39
Arizona			31 00	56 75				
Arkansas Eastern			69 30	20 00				
California				33 05				3,741 26
Colorado		$500 00	19 00				1,789 25	150 60
Connecticut				9 10		748 21		
Dakota				24 95				
Delaware				84 10				
District of Columbia	$7 40			40 70			92 00	
Florida, Northern	389 20		248 30					
Florida, Southern								239 06
Georgia			120 10					1,655 24
Idaho				52 44				
Illinois, Northern				424 90		544 75		3,000 00
Illinois, Southern				190 10				
Indiana	45 00		1,197 15					4,916 12
Iowa	1,200 00		345 15	240 95		2,712 70		
Kansas				70 55		28 50	307 57	
Kentucky	2,281 40			116 50		5,469 85		
Louisiana				103 45				1,332 60
Maine				20 45				
Maryland						525 00		
Massachusetts						3,016 02		
Michigan, Eastern			1,170 00	428 60				
Minnesota			1,187 55	48 65				
Mississippi, Northern				8 30				
Missouri, Eastern				55 80		4,301 80		
Missouri, Western			106 60					
Montana	330 00			16 80	100 00			
Nebraska		375 00	8 40	114 75				
New Hampshire				18 90				345 41
New Jersey	1,895 00		747 40	1,000 70				
New Mexico			233 60				1,005 00	
New York, Northern			1,950 05	1,104 76				8,004 10
New York, Southern			775 00	317 00			705 00	426 59
New York, Eastern	85 00							
North Carolina, Eastern	40 00		158 83	453 90				1,794 71
North Carolina, Western			1,136 64	3,476 75		473 50		3,017 41
Ohio, Northern	30 00							103 98
Ohio, Southern			42 50			5,520 61		
Oregon			10 00	33 95				1,405 61
Pennsylvania, Eastern					50 00			
Pennsylvania, Western								1,603 79
Rhode Island				154 35				
South Carolina				470 95				
Tennessee, Eastern				87 10				
Tennessee, Middle	77 80			345 70				942 66
Texas, Eastern					306 10			
Texas, Western				201 50	375 00			
Utah			22 85	20 20				
Vermont			35 75					
Virginia, Western			1,416 14		200 00		458 34	
West Virginia				39 55				
Wisconsin, Eastern						11 75		
Wisconsin, Western			52 13	28 05		688 72		40 02
Total	6,380 80	875 00	11,106 04	10,072 60	1,031 10	26,183 39	4,492 86	33,455 55

RECAPITULATION.

Attorneys	$6,380 80	Board of prisoners	$26,183 39
Assistant attorneys	875 00	Miscellaneous	4,492 86
Clerks	11,106 04	Marshals	33,455 55
Commissioners	10,072 60		
Rent	1,031 10	Aggregate	93,597 34

NOTE.—The miscellaneous claims are composed principally of contingent expenses of courts not paid by the marshals, but presented direct to the Treasury Department.

REAPPROPRIATIONS FOR 1875, AND PRIOR YEARS.

LETTER

FROM

THE SECRETARY OF THE TREASURY,

TRANSMITTING

Estimates of amounts to be reappropriated for the year 1875, *and for prior years.*

FEBRUARY 8, 1878.—Referred to the Committee on Appropriations and ordered to be printed.

TREASURY DEPARTMENT,
Washington, D. C., February 6, 1878.

SIR: I have the honor to transmit herewith, in compliance with the requirements of section 5 of "An act making appropriations for the service of the Government for the fiscal year ending June 30, 1875, and for other purposes," approved June 20, 1874, a statement of such of the balances of appropriations carried to the surplus fund, under the provisions of said act, as are required to be reappropriated for the service of the fiscal year 1875, and prior years, amounting, in the aggregate, to $477,636 21.

Very respectfully,

JOHN SHERMAN,
Secretary.

Hon. SAMUEL J. RANDALL,
Speaker of the House of Representatives.

Estimates of balances of appropriations carried to the surplus fund under the provisions of the fifth section of the act of June 20, 1874, required to be reappropriated for the service of the fiscal year ending June 30, 1875, and prior years.

[See Revised Statutes, Title 41, page 725, sections 3660 to 3671, and Statutes 18, chapter 129, page 370, section 3, act of March 3, 1875.]

General object. (Title of appropriation.)	Detailed objects of expenditure, and explanations.	Date of acts, resolutions, or treaties, authorizing or providing for the expenditures.	References to Statutes at Large, or to Revised Statutes. Vol. or R. S.	Page.	Sec.	Estimated amount which will be required for each detailed object of expenditure.	Total amount to be appropriated under each head of appropriation.	Amount in surplus fund available for reappropriation.
	TREASURY DEPARTMENT.							
	INTERNAL REVENUE.							
Expenses of assessing and collecting internal revenue.	Salaries and expenses of collectors, officers and agents, surveyors of distilleries, gaugers, and storekeepers, together with the expenses of carrying into effect the various provisions of the several acts providing internal revenue, excepting items otherwise estimated for, being—							
	For the fiscal year 1872, and prior years	March 3, 1871	16	483	1	....	$130 00	$262, 941 72
	For the fiscal year 1874	March 3, 1873	17	494	1	....	10, 000 00	479, 025 99
	Salaries and expenses of collectors, being for the service of the fiscal year ending June 30, 1875	June 20, 1874	18	93	1	$5, 000 00		
	Salaries and expenses of supervisors, storekeepers, agents, surveyors, gaugers, and miscellaneous expenses, being for the service of the fiscal year ending June 30, 1875	......do.......	.....	.....	.....	10, 000 00	15, 000 00	418, 671 46
Punishment for violation of internal-revenue laws.	To pay James F. Cunningham for services performed in 1869, in detecting and bringing to trial and punishment persons guilty of violating the internal-revenue laws, or conniving in such crime, being for the service of the fiscal year 1871, and prior years	July 12, 1870	16	239	1	....	577 00	3, 562 22
	Detecting and bringing to trial and punishment persons guilty of violating the internal-revenue laws, or conniving at the same, including payments for information and detection of such violations, being for the service of the fiscal year ending June 30, 1874	March 3, 1873	17	494	1	....	5, 000 00	85, 585 69
	Detecting and bringing to trial and punishment persons guilty of violating the internal-revenue laws, or conniving at the same, including payments for information and detection of such violations, being for the service of the fiscal year ending June 30, 1875	June 20, 1874	18	93	1	....	15, 000 00	39, 144 39

MISCELLANEOUS.

Salaries of designated depositaries.	Amount due Thomas Steel, late surveyor of customs and designated depositary at Pittsburgh, Pa., on account of commissions for receiving, safe-keeping, and disbursing public moneys, under act of March 2, 1833, as per letter of the First Comptroller of the Treasury, being for the service of 1874, and prior years	March 3, 1873	17	497	1		1,744 47	2,700 00
	To adjust the settled accounts of Thomas Steel, late surveyor of customs and designated depositary at Pittsburgh, Pa., involving no expenditure of money from the Treasury, being for the service of 1874, and prior years, $2,666 14.							
Life-saving Service, contingent expenses.	Amount due B. C. Sparrow, superintendent life-saving station, 2d district, East Orleans, Mass., for travelling expenses, as per certificate of the accounting officers of the Treasury Department, being for the service of the fiscal year 1875	Appropriated	18	205	1		11 55	35 72
Expenses of Revenue-cutter Service.	For the payment of amount due Harrison Loring, of Boston, Mass., for repairs to the revenue-steamer "Levi Woodbury," in December, 1873, $250.							
	NOTE.—This amount was chargeable to the appropriation for 1874, but the balance of the appropriation for that year reverted to the surplus fund June 30, 1876, and was reappropriated for the service of the fiscal year 1877 by act of July 31, 1876, (19 Stat., page 107.) Authority of law is requested, therefore, to pay the amount of Mr. Loring's bill from the unexpended balance reappropriated for the fiscal year 1877.							
Compensation in lieu of moieties.	For compensation, in lieu of moieties in certain cases, under the customs-revenue laws, $10,000.							
	NOTE.—The cases accruing in 1875, and previously, which have not been settled, and in which informers' claims are pending, require about ten thousand dollars. As the appropriation of $200,000 for the fiscal year 1876 is believed to be sufficiently large to admit of the payment of these unsettled claims therefrom, authority of law is requested for the use of the appropriation for 1876, for the payment of claims which accrued in 1875, and previously, not to exceed ten thousand dollars, ($10,000.)							
Customs Service	For the settlement of balances due disbursing officers for expenditures made by them in pursuance of law, on account of the following appropriations:							
	Salaries of light-house keepers, fiscal year 1871, and prior years	July 15, 1870	16	303	1		140 00	5,814 84
	Salaries of light-house keepers, fiscal year 1873	June 10, 1872	17	356	1		95 22	570 99
	Supplies of light-houses, fiscal year 1872	March 3, 1871	16	507	1		7 63	8 71
	Revenue-cutter Service, fiscal year 1872	March 3, 1871	16	496	1		6 00	140,659 15
	Preserving life and property from shipwrecked vessels, fiscal year 1874	March 3, 1873	17	510	1		180 00	7,006 45

Estimates of balances of appropriations carried to the surplus fund, &c.—Continued.

General object. (Title of appropriation.)	Detailed objects of expenditure, and explanations.	Date of acts, resolutions, or treaties, authorizing or providing for the expenditures.	References to Statutes at Large, or to Revised Statutes. Vol. or R. S.	Page.	Sec.	Estimated amount which will be required for each detailed object of expenditure.	Total amount to be appropriated under each head of appropriation.	Amount in surplus fund available for reappropriation.
	MISCELLANEOUS—Continued.							
Customs Service—Continued.	Preserving life and property from shipwrecked vessels, contingent expenses, fiscal year 1874	March 3, 1873	17	511	1	....	$315 84	$390 62
	Life-saving Service, fiscal year 1875	June 23, 1874	18	205	1	....	18 00	6,138 49
Inquiries into the causes of steam-boiler explosions.	To meet the expenses attendant upon experiments made as to the causes of steam-boiler explosions, it is desired by the Boiler Commission that the balance ($4,064 96) of the appropriation made by the act of March 3, 1873, be continued and made available for said purpose	March 3, 1873	17	629	1	....	4,064 96	4,064 96
Refunding moneys for lands redeemed.	Refunding the principal and interest of the purchase-money of lands redeemed after the sale of the same, under "An act further to amend an act entitled 'An act for the collection of direct taxes in the insurrectionary districts within the United States, and for other purposes,'" approved June 7, 1862, as follows: To pay George Billow the sum of $410, with interest from December 28, 1864, to date of payment	.... Feb. 6, 1863	R. S. 12	729 640	3689 1	....	410 00	(Indefinite.)
Repayment for lands sold for direct taxes.	To repay to purchasers evicted through failure of title from lands sold to them in insurrectionary districts for direct taxes, as follows: To Julia D. Evans, $775; to James Garibaldi, surviving partner of Garibaldi & Veil, $4,000	....	R. S.	729	3687	....	4,775 00	(Indefinite.)
Refunding taxes illegally collected.	To refund to persons money collected from them without warrant of law, as in payment of dues under the direct-tax laws	....	R. S.	730	3689	....	163 00	(Indefinite.)
Refunding taxes illegally collected, (Internal Revenue.)	To refund and pay back taxes erroneously or illegally assessed or collected under the internal-revenue laws	....	R. S.	730	3689	....	48,753 33	(Indefinite.)
Redemption of stamps, (Internal Revenue.)	To repay the amount or value paid for stamps which may have been spoiled, destroyed, or rendered useless or unfit for the purpose intended, or which, through mistake, may have been improperly or unnecessarily used	....	R. S.	730	3689	....	194 83	(Indefinite.)

Allowance or drawback, (Internal Revenue.)	To pay allowance or drawback on articles on which any internal duty or tax shall have been paid when said articles are exported		R. S.	730	3689		1,253 69	(Indefinite.)
Repayment of taxes on distilled spirits destroyed by casualty, (Internal Revenue.)	Refunding taxes collected on distilled spirits in bond which have been destroyed by fire or other casualty		R. S.	622	3221		41 30	(Indefinite.)
Refunding to national banking associations excess of duty.	Amounts found due the following national banks by the accounting officers of the Treasury Department for excess of duty paid prior to July 1, 1866, viz: Second National Bank of Boston, Mass. $833 31 Western National Bank of Baltimore, Md. 534 48 First National Bank of Baltimore, Md. 358 96 Second National Bank of Baltimore, Md. 332 17 National Mechanics' and Traders' Bank of Portsmouth, N. H. 104 85 National Bank of Commerce, Boston, Mass. 1,928 40 Leather Manufacturers' National Bank of New York 130 94 National Bank of Commerce, Philadelphia 420 00 Merchants' Exchange National Bank of the City of New York 528 84 Merchants' National Bank of the City of New York 1,268 79 6,440 74		R. S.	1015	5218		6,440 74	(Indefinite.)
	Total Treasury Department						114,252 56	1,456,321 40

WAR DEPARTMENT.

NOTE.—Estimates for reappropriation for Medical and Surgical History of the War, 1878, $12,883 85; expenses of military convicts, 1872, 1873, and 1874, $614 88; and portions of amounts now included in Medical and Hospital department, 1871, and prior years, $2,229 63; draft and substitute fund, 1871, and prior years, $160 19, were submitted to Congress October 15, 1877. (See page 25, Ex. Doc. No. 5, House of Representatives, 45th Congress, 1st session.)

Examinations and surveys on western and northwestern rivers.	Reappropriation of balance of $50,000, appropriated by act of July 15, 1870	Appropriated	16	300	1		$334 40	$334 40
Construction of sea-coast mortar-batteries.	Reappropriation of balance of $100,000, appropriated by act of June 10, 1872	Appropriated	17	377	1		301 50	301 50

Estimates of balances of appropriations carried to the surplus fund, &c.—Continued.

General object. (Title of appropriation.)	Detailed objects of expenditure, and explanations.	Date of acts, resolutions, or treaties, authorizing or providing for the expenditures.	References to Statutes at Large, or to Revised Statutes. Vol. or R. S.	Page.	Sec.	Estimated amount which will be required for each detailed object of expenditure.	Total amount to be appropriated under each head of appropriation.	Amount in surplus fund available for reappropriation.
	WAR DEPARTMENT—CONTINUED.							
Surveys and estimates for improvements on transportation routes to the seaboard.	Reappropriation of balance of $10,000, appropriated by act of March 3, 1875	Appropriated.	18	461	1	....	$851 56	$851 56
Commission to investigate and report plan for reclamation of alluvial basin of Mississippi river.	Reappropriation of balance of $25,000, appropriated by act of June 22, 1874	Appropriated.	18	199	3	....	5,000 00	5,000 00
Military-road from Santa Fé to Fernandes de Taos, New Mexico.	Reappropriation of balance of $6,644 80, appropriated by act of March 3, 1875	Appropriated.	18	391	1	....	595 35	595 35
	NOTE.—These items were carried to the surplus fund June 30, 1877, by surplus-fund warrant No. 247.							
Pay, &c., of the Army....	For payment of amounts certified to be due by the accounting officers of the Treasury Department for pay, travelling, and general expenses of the Army, being for the service of the fiscal year 1874	March 3, 1873	17	544	1	....	2,529 40	5,079 02
	NOTE.—For schedule of claims, see Appendix, marked "A."							
Medical and Hospital department.	For payment of amounts certified to be due by the accounting officers of the Treasury Department for medical and hospital supplies and incidental expenses of the Medical department of the Army, being—							
	For the service of the fiscal year 1871, and prior years	March 3, 1869	15	316	1	....	1,897 08	757,808 52
	For the service of the fiscal year 1872	March 3, 1871	16	523	1	....	134 55	6,643 70
	For the service of the fiscal year 1875	June 16, 1874	18	74	1	....	198 00	1,539 12
	NOTE.—For schedule of claims, see Appendix, marked "A."							

Expenses of military convicts.	For payment of amounts certified to be due by the accounting officers of the Treasury Department for payment of costs and charges of State penitentiaries, for the care, clothing, maintenance, and medical attendance of United States military convicts confined in them:							
	For the service of the fiscal year 1872	March 3, 1871	16	507	1	....	138 88	155 23
	For the service of the fiscal year 1873	June 10, 1872	17	367	1	....	238 00	12, 787 18
	For the service of the fiscal year 1874	March 3, 1873	17	528	1	....	238 00	6, 990 67
	NOTE.—For schedule of claims, see Appendix, marked "A."							
Draft and substitute fund.	For payment of amounts certified to be due by the accounting officers of the Treasury Department for expenses of the draft and for the procuration of substitutes:							
	For the service of the fiscal year 1871, and prior years	Jan. 16, 1864	13	400	....	....	160 19	121, 524 15
	NOTE.—For schedule of claims, see Appendix, marked "A."							
Bounty to volunteers, their widows, and legal heirs.	To pay claims of enlisted men of the volunteer service, or their widows and legal heirs, for bounty certified to be due them by the accounting officers of the Treasury Department, being for the service of the fiscal year 1871, and prior years	July 22, 1861	12	270	6	....	50, 951 82	131, 367 38
	NOTE.—For schedule of claims, see Appendix, marked "A."							
Travelling expenses of California and Nevada volunteers.	For payment of amount certified to be due Charles Werneke, private Fifth California volunteers, by the accounting officers of the Treasury Department:							
	For the service of the fiscal year 1871, and prior years	March 2, 1867	14	487	7	....	210 24	(Indefinite.)
Collecting, drilling, and organizing volunteers.	For payment of amount certified to be due George Hey, for subsisting volunteer recruits in 1863, by the accounting officers of the Treasury Department, being for the service of the fiscal year 1871, and prior years	Aug. 5, 1861	12	316	1	....	108 12	1, 618, 974 60
Transportation of the Army and its supplies.	For payment of amounts certified to be due by the accounting officers of the Treasury Department for transportation of the Army, being—							
	For the service of the fiscal year 1871, and prior years	July 15, 1870	16	317	1	....	82, 969 93	115, 692 13
	For the service of the fiscal year 1873	June 6, 1872	17	260	1	....	281 32	281 32
	For the service of the fiscal year 1874	March 3, 1873	17	545	1	$40, 712 53		
	For payment of amounts that may be certified to be due by the accounting officers of the Treasury Department for transportation of the Army, being for the service of the fiscal year 1874	......do......	.....	.....	.....	10, 000 00	50, 712 53	626, 995 22
	NOTE.—For schedule of claims, see Appendix "A." The claims included under the appropriation for 1873 are printed in Appendix "K" of the deficiency estimates.							

Estimates of balances of appropriations carried to the surplus fund, &c.—Continued.

General object. (Title of appropriation.)	Detailed objects of expenditure, and explanations.	Date of acts, resolutions, or treaties, authorizing or providing for the expenditures.	References to Statutes at Large, or to Revised Statutes. Vol. or R. S.	Page.	Sec.	Estimated amount which will be required for each detailed object of expenditure.	Total amount to be appropriated under each head of appropriation.	Amount in surplus fund available for reappropriation.
	WAR DEPARTMENT—CONTINUED.							
Barracks and quarters...	For payment of amounts certified to be due by the accounting officers of the Treasury Department for rent or hire of quarters for troops and for officers on military duty, being—							
	For the service of the fiscal year 1871, and prior years......	July 15, 1870	16	317	1	....	$27 12	$313 36
	For the service of the fiscal year 1872	March 3, 1871	16	523	1	....	268 80	77, 147 51
	For the service of the fiscal year 1873	June 6, 1872	17	260	1	....	1, 742 00	42, 389 77
	For the service of the fiscal year 1874	March 3, 1873	17	545	1	....	30 00	21, 672 15
	NOTE.—For schedule of claims, see Appendix "A." The claims included under the appropriation for 1871, and prior years, are printed in Appendix "K" of the deficiency estimates.							
Regular supplies, Quartermasters' department.	For payment of amounts certified to be due by the accounting officers of the Treasury Department for regular supplies of the Army, being—							
	For the service of the fiscal year 1871, and prior years......	July 15, 1870	16	316	1	$23, 359 84		
	For payment of amounts that may be certified to be due by the accounting officers of the Treasury for regular supplies of the Army, being for the service of the fiscal year 1871, and prior years	.....do.......	.....	.....	.....	15, 000 00	38, 359 84	222, 046 12
	For payment of amounts certified to be due by the accounting officers of the Treasury Department for regular supplies of the Army, being—							
	For the service of the fiscal year 1872	March 3, 1871	16	522	1	....	366 10	89, 818 73
	For the service of the fiscal year 1873	June 6, 1872	17	259	1	....	682 59	78, 716 52
	For the service of the fiscal year 1874	March 3, 1873	17	544	1	....	504 95	188, 622 80
	For the service of the fiscal year 1875	June 16, 1874	18	72	1	247 89		
	For payment of amounts that may be certified to be due by the accounting officers of the Treasury for regular supplies of the Army, being for the service of the fiscal year 1875......................	.....do.......	.....	.....	.....	1, 000 00	1, 247 89	223, 916 30
	NOTE.—For schedule of claims, see Appendix, marked "A."							

Incidental expenses, Quartermasters' department.	For payment of amounts certified to be due by the accounting officers of the Treasury Department for incidental expenses of the Army, being—							
	For the service of the fiscal year 1871, and prior years	July 15, 1870	16	316	1	13,410 93		
	For payment of amounts that may be certified to be due by the accounting officers of the Treasury Department for incidental expenses of the Army, being for the service of the fiscal year 1871, and prior years	......do				10,000 00		
							23,410 93	131,951 70
	For payment of amounts certified to be due by the accounting officers of the Treasury Department for incidental expenses of the Army, being for the service of the fiscal year 1873	June 6, 1872	17	259	1	....	2,385 51	14,190 19
	For the service of the fiscal year 1874	March 3, 1873	17	544	1	....	477 49	477 49
	For the service of the fiscal year 1875	June 16, 1874	18	73	1	2,691 75		
	For payment of amounts that may be certified to be due by the accounting officers of the Treasury Department for incidental expenses of the Army, being for the service of the fiscal year 1875	.....do				10,000 00		
							12,691 75	111,149 25
	NOTE.—For schedule of claims, see Appendix, marked "A." The claims included under the appropriation for 1874 are printed in Appendix "K" of the deficiency estimates.							
Horses for cavalry and artillery.	For payment of amounts certified to be due by the accounting officers of the Treasury Department for purchase of horses for the cavalry and artillery, being for the service of the fiscal year 1871, and prior years	March 3, 1869	15	317	1	....	395 00	395 00
	NOTE.—For schedule of claims, see Appendix, marked "K," printed in the deficiency estimates.							
National cemeteries	For payment of amounts certified to be due by the accounting officers of the Treasury Department for establishing and maintaining national cemeteries, being for the service of the fiscal year 1871, and prior years	July 15, 1870	16	317	1	....	2 49	2 49
	NOTE.—For schedule of claims, see Appendix, marked "K," printed in the deficiency estimates.							
Clothing, camp and garrison equipage.	For payment of amounts certified to be due by the accounting officers of the Treasury Department for clothing the Army, being—							
	For the service of the fiscal year 1871, and prior years	March 3, 1865	13	497	1	....	58 05	263,620 71
	For the service of the fiscal year 1873	June 6, 1872	17	260	1	....	239 82	14,680 43
	For the service of the fiscal year 1874	March 3, 1873	17	545	1	....	11 35	19,494 16
	NOTE.—For schedule of claims, see Appendix, marked "A."							
Transportation of officers and their baggage.	For payment of amounts certified to be due by the accounting officers of the Treasury Department for transportation of officers and their baggage when travelling on duty, being for the service of the fiscal year 1871, and prior years	July 15, 1870	16	316	1	923 17		

Estimates of balances of appropriations carried to the surplus fund, &c.—Continued.

General object. (Title of appropriation.)	Detailed objects of expenditure, and explanations.	Date of acts, resolutions, or treaties, authorizing or providing for the expenditures.	References to Statutes at Large, or to Revised Statutes. Vol. or R. S.	Page.	Sec.	Estimated amount which will be required for each detailed object of expenditure.	Total amount to be appropriated under each head of appropriation.	Amount in surplus fund available for reappropriation.
	WAR DEPARTMENT—CONTINUED.							
Transportation of officers and their baggage—Continued.	For payment of amounts that may be certified to be due by the accounting officers of the Treasury Department for transportation of officers and their baggage when travelling on duty, being for the service of the fiscal year 1871, and prior years...	July 15, 1870	16	316	1	$500 00	$1,423 17	$5,715 86
	NOTE.—For schedule of claims, see Appendix, marked "A."							
Relief of persons suffering from the ravages of grasshoppers. (Limited to Sept. 1, 1875.)	For payment of amounts certified to be due by the accounting officers of the Treasury Department for expenses of relief of persons suffering from the ravages of grasshoppers, incurred prior to September 1, 1875	Feb. 10, 1875	18	314	1	....	663 99	15,502 94
	NOTE.—For schedule of claims, see Appendix, marked "A."							
Subsistence of the Army	For payment of amounts certified to be due by the accounting officers of the Treasury Department for subsistence of the Army, being for the service of the fiscal year 1871, and prior years	July 15, 1870	16	315	1	5,818 71		
	For payment of amounts that may be certified to be due by the accounting officers of the Treasury Department for subsistence of the Army, being for the service of the fiscal year 1871, and prior years	.....do	....	....	....	5,000 00	10,818 71	887,542 15
	For payment of amounts certified to be due by the accounting officers of the Treasury Department for subsistence of the Army, being—							
	For the service of the fiscal year 1873	June 6, 1872	17	259	1	....	1 90	365,812 19
	For the service of the fiscal year 1874	March 3, 1873	17	544	1	....	1 90	702 58
	For the service of the fiscal year 1875	June 16, 1874	18	72	1	....	8 25	63,016 12
	NOTE.—For schedule of claims, see Appendix, marked "A."							
Pay, transportation, services, and supplies of	For payment of amounts certified to be due by the accounting officers of the Treasury Department, for pay, transportation,							

Oregon and Washington volunteers in 1855 and 1856.	services, and supplies of Oregon and Washington volunteers in 1855 and 1856, being for the service of the fiscal year 1871, and prior years	March 2, 1861	12	198	1	17, 759 69		
	For payment of amounts that may be certified to be due by the accounting officers of the Treasury Department for pay, transportation, services, and supplies of Oregon and Washington volunteers in 1855 and 1856, being for the service of the fiscal year 1871, and prior years	....do	....	....	....	25, 000 00	42, 759 69	286, 992 20
	NOTE.—For schedule of claims, see Appendix, marked "A."							
	Total War Department						336, 430 16	6, 538, 802 77
	INTERIOR DEPARTMENT.							
	PENSIONS.							
Army pensions	Amounts due J. L. Collins, late pension agent at Santa Fé, New Mexico, and J. B. Jones, late pension agent at Fort Gibson, as per letter of the Third Auditor of the Treasury Department, being for the service of the fiscal year 1871, and prior years	July 11, 1870	16	221	1	....	$455 19	$8, 155, 711 67
	Amount due the Central Railroad of New Jersey, for transportation, as per letter of the Third Auditor of the Treasury, being for the service of the fiscal year 1874	Jan. 10, 1873	17	407	1	....	90	222, 255 58
	INDIAN AFFAIRS.							
Pay of superintendents and Indian agents.	Amounts due E. R. Roberts ($1 37) and Chas. T. Brown, ($61 14,) late Indian agents, as per certificate of the accounting officers, being for the service of the fiscal year 1873, and prior years	May 29, 1872	17	165	1	....	62 51	79, 071 78
	Amount due W. F. M. Arny, late Indian agent, as per certificate of the accounting officers, being for the service of the fiscal year 1874	Feb. 14, 1873	17	438	1	....	264 86	6, 362 57
	Amount due Thos. M. Chase, late Indian agent, as per certificate of the accounting officers, being for the service of the fiscal year 1875	June 22, 1874	18	146	1	....	33 38	726 30
Pay of interpreters	Amount due W. F. M. Arny, late Indian agent, as per certificate of the accounting officers, being for the service of the fiscal year 1874	Feb. 14, 1873	17	439	1	....	76 04	2, 153 69
Contingencies of the Indian department.	Amounts found due, as per certificate of the accounting officers, as follows: E. R. Roberts, late Indian agent, $14 64; Albert L. Green, late Indian agent, $4 52; Geo. A. Crowell, late Indian agent, $37 06; W. B. Hazen, colonel Sixth U. S. Infantry, late Peace Commissioner, $95 50—total, $151 72; being for the service of the fiscal year 1873, and prior years	May 29, 1872	17	166	1	....	151 72	151 72

Estimates of balances of appropriations carried to the surplus fund, &c.—Continued.

General object. (Title of appropriation.)	Detailed objects of expenditure, and explanations.	Date of acts, resolutions, or treaties, authorizing or providing for the expenditures.	References to Statutes at Large, or to Revised Statutes. Vol. or R. S.	Page.	Sec.	Estimated amount which will be required for each detailed object of expenditure.	Total amount to be appropriated under each head of appropriation.	Amount in surplus fund available for reappropriation.
	INDIAN AFFAIRS—Continued.							
Contingencies of the Indian department—Continued.	Amount due Geo. A. Crowell, late Indian agent, as per certificate of the accounting officers, being for the service of the fiscal year (1874) 1873	Feb. 14, 1873	17	440	1	....	$124 98	$251 56
	Amount due Geo. A. Crowell, late Indian agent, as per certificate of the accounting officers, being for the service of the fiscal year 1875	June 22, 1874	18	148	1	....	336 53	633 22
Incidental expenses, Indian service in Arizona.	Amount due Cornelius Brice for services, as per certificate of the accounting officers, being for the service of the fiscal year (1874) 1873	Feb. 14, 1873	17	459	1	....	117 05	1,724 43
Incidental expenses, Indian service in Montana.	Amount due W. J. Kountz for transportation, as per certificate of the accounting officers, being for the service of the fiscal year 1875	June 22, 1874	18	171	1	....	552 45	562 45
Incidental expenses, Indian service in Oregon.	Amount due Benj. Simpson, late Indian agent, as per certificate of the accounting officers, being for the service of the fiscal year 1873, and prior years	May 29, 1872	17	187	1	....	9 95	97 72
Incidental expenses, Indian service in New Mexico.	Amount due W. F. M. Arny, late Indian agent, as per certificate of the accounting officers, being for the service of the fiscal year (1874) 1873	Feb. 14, 1873	17	460	1	....	10 34	10 34
	Amount due W. F. M. Arny, late Indian agent, as per certificate of the accounting officers, being for the service of the fiscal year 1875	June 22, 1874	18	171	1	....	48 70	48 70
Incidental expenses, Indian service in Nevada.	Amount due J. P. C. Shanks, late Indian agent, as per certificate of the accounting officers, being for the service of the fiscal year 1875	June 22, 1874	18	171	1	....	133 42	133 42
Fulfilling treaties with Chippewas of Lake Superior and the Mississippi.	Amount due George Bonga for gilling-twine, as per certificate of the accounting officers, being for the service of the fiscal year 1873, and prior years	May 29, 1872	17	168	1	....	291 69	291 69

Fulfilling treaties with Chippewas of the Mississippi.	Amount due George Bonga for gilling-twine, as per certificate of the accounting officers, being for the service of the fiscal year 1873, and prior years	do.					72 81	5,331 84
Fulfilling treaties with Navajoes.	Amount due W. F. M. Arny, late Indian agent, as per certificate of the accounting officers, being for the service of the fiscal year (1874) 1873	Feb. 14, 1873	17	449	1		58 94	2,566 69
Fulfilling treaties with Rogue Rivers.	Amounts due for wheat and supplies, as per certificate of the accounting officers, as follows: E. Hartless, $71 84; Chambers & Hulse, $389 19; being for the service of the fiscal year 1873, and prior years	May 29, 1872	17	180	1		461 03	535 11
Fulfilling treaties with Sioux of different tribes, including Santee Sioux of Nebraska.	Amount due De Witt C. Poole, captain 22d Infantry, late acting Indian agent, as per certificate of the accounting officers, being for the service of the fiscal year 1873, and prior years	May 29, 1872	17	182	1		3 37	109,028 65
	Amount due Walter P. Jenney, geologist, reimbursement of amounts paid by him on account of Black Hills surveying expedition, as per certificate of the accounting officers, being for the service of the fiscal year 1875	June 22, 1874	18	167	1		571 19	43,115 84
Maintaining peace among and with the various tribes and bands of Indians.	Amount due De Witt C. Poole, captain 22d Infantry, late acting Indian agent, as per certificate of the accounting officers, being for the service of the fiscal year 1873, and prior years	April 10, 1869	16	40	4		7 63	1,213 41
	MISCELLANEOUS.							
Expenses of the eighth census.	For expenses of the eighth census	July 15, 1870 May 18, 1872 March 3, 1873 June 23, 1874	16 17 17 18	314 131 528 230	1 1 1 4		5,000 00	16,365 37
Surveying public lands in Louisiana.	Amount due George O. Elms, deputy surveyor, under contract dated June 20, 1874, being for the service of the fiscal year 1874	March 3, 1873	17	515	1		216 25	14,312 20
	NOTE.—The unexpended balance of $14,312 20 of the appropriation to which the foregoing amount was chargeable, was carried to "Surplus Fund" June 30, 1876. The amount found to be due the deputy surveyor is therefore submitted for reappropriation.							
Refunding money for lands erroneously sold.	To pay to the purchaser or purchasers the sum or sums of money received for lands erroneously sold by the United States		R. S.	733	3689		1,892 80	(Indefinite.)
	NOTE.—For schedule of claims, under this appropriation, see Appendix, marked "B."							
	Total Interior Department						10,953 73	8,662,655 95

Estimates of balances of appropriations carried to the surplus fund, &c.—Continued.

General object. (Title of appropriation.)	Detailed objects of expenditure, and explanations.	Date of acts, resolutions, or treaties, authorizing or providing for the expenditures.	References to Statutes at Large, or to Revised Statutes. Vol. or R. S.	Page.	Sec.	Estimated amount which will be required for each detailed object of expenditure.	Total amount to be appropriated under each head of appropriation.	Amount in surplus fund available for reappropriation.
	POST OFFICE DEPARTMENT.							
Deficiency in the postal revenues.	To pay Bryan Tyson for carrying the mails between Selma and Forest Lawn, Texas, from October 26, 1868, to June 30, 1869, (route No. 7638)	March 30, 1868	15	55	3	$29 32		
	To pay Haywood Stillwell & Co., operating the Hannibal and Naples railroad for transporting the mails between Hannibal and Naples from January 1 to June 30, 1870, (route No. 11,889,) being for the service of the fiscal year 1871, and prior years	March 3, 1869	15	323	2	1,000 00	$1,029 32	$1,448,184 67
	Old Dominion Steamship Company for transporting the United States mails between Norfolk, Va., and New York, N. Y., from July 1, 1871, to June 30, 1872, (route No. 4725)	March 3, 1871	16	572	3	750 00		
	New Brunswick and Canada Railroad Company for transporting the mails between boundary line, St. Stephen's, and McAdam Junction, from November 1, 1871, to June 30, 1872, (route No. 14)	do				1,935 73		
	To reimburse William Percival, postmaster at Fort Gibson, Indian Territory, amount paid by him for mail messenger service from April 15 to June 30, 1872, being for the service of the fiscal year 1872	do				282 50	2,968 23	306,735 34
	To reimburse David Frazier, postmaster at Akron, Mo., for payment made to Elisha Willis for carrying the mails between Akron and New Buda from January 1 to March 31, 1873, (route No. ——)	June 1, 1872	17	202	4	18 70		
	Lehigh Valley Railroad Company for transporting the mails between their depot and the post office at Hazleton, Pa., from July 1, 1872, to June 30, 1873, (route No. 2416)	do				180 00		
	New Brunswick and Canada Railroad Company for transporting the mails between boundary line, St. Stephen's, and McAdam Junction, from July 1, 1872, to June 30, 1873, (route No. 14, Maine,) being for the service of the fiscal year 1873	do				4,000 00	4,198 70	680,830 11

	Lehigh Valley Railroad Company for carrying the mails between their depot and the post office at Hazleton, Pa., from July 1, 1873, to June 30, 1874, (route 2416)	March 3, 1873	17	559	3	180 00		
	New Brunswick and Canada Railroad Company for transporting the mails between boundary line, St. Stephen's, and McAdam junction, from July 1, 1873, to June 30, 1874, (route 14, Maine)	......do......	.....	.....	.....	4,000 00		
	Being for the service of the fiscal year 1874.						4,180 00	1,006,574 51
	Lehigh Valley Railroad Company, for carrying the mails between their deport and the post office at Hazleton, Pa., from July 1, 1874, to June 30, 1875, (route 2416)	June 23, 1874	18	232	3	180 00		
	New Brunswick and Canada Railroad Company for transporting the mails between boundary line, St. Stephen's, and McAdam Junction, from July 1, 1874, to December 31, 1874, (route 14, Maine)	......do......	.....	.....	.....	2,000 00		
	To pay Charles Walsh, of Chicago, Ill., for increase of mail-messenger service between the Baltimore and Ohio Railroad depot and the post office, both at Chicago, Ill., from December 28, 1874, to June 30, 1875	......do......	.....	.....	.....	1,226 08		
	To pay R. B. Hollingsworth, of Texas, for one month's extra pay on curtailment of service on route No. ——, Texas, per order No. 3075, dated June 27, 1875	......do......	.....	.....	.....	11 66		
	To pay T. K. Summers, of Kentucky, amount accrued on account of fiscal year 1875, under order No. 5538, dated October 1, 1877, modifying order of May 21, 1874, curtailing route, and allow one month's extra pay on said curtailment, (route No. 20,182, Kentucky)	......do......	.....	.....	.....	197 77		
	Being for the service of the fiscal year 1875.						3,615 51	114,353 13
	Total Post Office Department	....	.....	.....	.....	....	15,991 76	3,556,677 76
	JUDICIAL.							
Expenses of United States courts.	**Amount due S. B. Packard, late United States marshal, district of Louisiana, as per certificate of the accounting officers of the Treasury Department, being for the service of the fiscal year 1871, and prior years**	Appropriated	16	308	1	....	$8 00	$666,627 29
	Total Judicial	....	.....	.....	.....	....	8 00	666,627 29
	RECAPITULATION.							
	Treasury Department	....	.....	.....	.....	....	$114,252 56	$1,456,321 40
	War Department	....	.....	.....	.....	....	336,430 16	6,538,802 77
	Interior Department	....	.....	.....	.....	....	10,953 73	8,662,655 95
	Post Office Department	....	.....	.....	.....	....	15,991 76	3,556,677 76
	Judicial	....	.....	.....	.....	....	8 00	666,627 29
	Grand total	....	.....	.....	.....	....	477,636 21	20,881,085 17

APPENDIX.

APPENDIX A.

Schedule of claims embraced in the estimates submitted by the Secretary of War. *(See pages* **6** *to* **10.)**

PAY, &C., OF THE ARMY, 1874.—(Reappropriation.)

Arrears of pay:	
Daniel Chase, late Major U. S. A	$2,437 50
John McCaffrey, Company "M," 8th U. S. Cavalry	7 10
Michael Cullen, Company "M," 8th U. S. Cavalry	27 61
James Wilson, Company "I," 7th U. S. Infantry	53 03
C. W. Wingard, paymaster	4 16
Total	2,529 40

MEDICAL AND HOSPITAL DEPARTMENT, 1871 AND PRIOR YEARS.—(Reappropriation.)

Services:	
S. S. Bicknell, late acting assistant surgeon	$36 11
Services as nurse:	
John C. L. Campbell, late private 80th Indiana Volunteers	28 75
Hospital supplies:	
James Gormley	671 75
Services:	
John W. Moore, M. D	33 50
Medicines:	
James M. Perry	42 65
Services:	
S. B. Thompson, M. D	106 66
A. L. Taylor, contract surgeon	447 66
J. B. Torbert, contract surgeon	50 00
H. G. Whitlock, contract surgeon	180 00
George C. Wheeler, contract surgeon	300 00
Total	1,897 08

MEDICAL AND HOSPITAL DEPARTMENT, 1872.—(Reappropriation.)

Medical supplies:	
William Wells & Co	$134 55

MEDICAL AND HOSPITAL DEPARTMENT, 1875.—(Reappropriation.)

Services, &c.:	
Henry Lambert	$198 00

EXPENSES OF MILITARY CONVICTS.—(Reappropriation.)

1872	$138 88
1873	238 00
1874	238 00

(Being amounts due the Tennessee penitentiary for keeping military convicts from December 1, 1871, to June 30, 1874.)

Schedule of claims, &c.—Continued.

DRAFT AND SUBSTITUTE FUND, 1871 AND PRIOR YEARS.—(Reappropriation.)

Transportation services:	
Barnes & Co	$49 20
Erastus L. Gay, special detective	26 67
The National Bank of Malone, New York, owner of unpaid check issued by Captain F. H. Barroll, disbursing officer	93
Friend Palmer, owner of check as above	7 44
Riggs & Co., owner of unpaid check issued by Captain R. Lodor, disbursing officer	3 00
Gutterin Peterson, payee of check issued by Captain F. H. Barroll, disbursing officer	1 86
Transportation:	
W. W. Sweetser	71 09
Total	160 19

BOUNTY TO VOLUNTEERS, THEIR WIDOWS AND LEGAL HEIRS, 1871 AND PRIOR YEARS—(Reappropriation.)

* John Hanna, 6th Mich. Cav	$75 00
* Francis M. Davis, 46th Ind. Vols	100 00
* Charles Young, 2d La. Vols	75 00
* Thos. Turk, 1st Cal. Cav	200 00
* Hy. H. Pillsbury, 148th N. Y. Vols	75 00
* Milton Kemp, 6th W. Va. Cav	100 00
* Joseph A. Davis, 9th W. Va. Vols	165 00
* Harlan P. Green, 7th Pa. Cav	100 00
* Geo. G. Neiman, 52d Pa. Vols	100 00
* Jas. Harkness, 35th Iowa Vols	100 00
* Wm. S. Brown, 1st M. M. B. Cav	100 00
* John Kelly, 14th N. Y. Cav	75 00
* Sam'l Aladire, 13th Ind. Vols	145 00
* Jas. J. Adock, 33d Ill. Vols	160 00
* John W. Beverly, 1st Ohio Cav	33 33
* H. P. Beaman, 3d Vt. Vols	100 00
* John P. Benson, 1st Ill. Cav	100 00
* S. H. Barto, 104th Ohio	75 00
* C. R. Bowen, 4th Mich	75 00
* Karl Backert, 62d Pa	100 00
* E. W. White, 4th Vt	100 00
* G. F. Cowan, 12th Wis	100 00
* H. H. White, 9th Ohio Cav	60 00
* Elry Boon, 32d Ohio	100 00
* Dan Savage, 14th Ohio	340 00
* C. G. Lathams, P. T. Carlisle barracks, U. S. A	100 00
* Wm. H. Fuller, 1st Mass	100 00
* Henry Bell, 77th U. S. C. T	100 00
* Solomon Hobbs, 12th U. S. C. H. A	199 27
* Hugh Cartan, 3d U. S. Cav	88 40
* Daniel Jenkins, 2d U. S. Cav	200 00
* Daniel Pitchett, 10th U. S. C. T	100 00
* Peter Threet, 10th U. S. C. T	100 00
* Bolton McLane, 5th U. S. C. H. A	289 00
* Jacob Green, 4th U. S. C. H. A	100 00
* Matt Jackson, 4th U. S. C. H. A	100 00
* Samuel Malone, 4th U. S. C. H. A	100 00
* Nelson Holiday, 8th U. S. C. H. A	300 00
* John H. Garner, 14th U. S. C. T	100 00
* Benjamin Key, 19th U. S. C. T	200 00
* Daniel McKelly, 14th U. S. C. T	100 00
* Ben Ross, 4th U. S. C. H. A	100 00
* James Booker, 108th U. S. C. T	25 00
* Henderson Birt, 63d U. S. C. T	100 00
* Frank Ankram, 33d U. S. C. T	100 00
* Henry Adams, 33d U. S. C. T	100 00

Schedule of claims, &c.—Continued.

*Prince Weathers, 33d U. S. C. T.	$100 00
*Michael Hinds, 97th U. S. C. T.	100 00
*Joseph Whitfield, 35th U. S. C. T	100 00
*Charles Mullen, 36th U. S. C. T	100 00
*William Johnson, 23d U. S. C. T	300 00
*Edward Proctor, 49th U. S. C. T	100 00
*Jordan Gray, 35th U. S. C. T.	100 00
*Charles C. Kinman, 23d Ky	100 00
*William H. Smith, 7th Tenn. Cav	100 00
*William S. George, 8th Mo. Cav	40 00
*Adam Sander, 1st Mo. L. Art.	310 00
*Jas. K. P. Wilson, 21st Mo.	100 00
*Martin V. Peters, 11th V. R. C	140 00
*Thomas J. Helbrigle, 10th Tenn.	100 00
*Ely Meyenne, 1st Indpt. Co. V. R. C.	200 00
William Battan, 56th U. S. C. T	100 00
Thomas Lastry, 128th U. S. C. T.	100 00
David R. Conway, 102d U. S. C. T	160 00
Lyman Small, 21st U. S. C. T	100 00
James Scott, 109th U. S. C. T	100 00
Franklin Johnston, 63d U. S. C. T	100 00
John Malone, 36th U. S. C. T	100 00
Andrew Gardner, 58th U. S. C. T	100 00
Scipio Miller, 33d U. S. C. T	100 00
William Harvey, 40th U. S. C. T	300 00
Alfred Walker, 62d U. S. C. T	100 00
Thornton Rumsey, 123d U. S. C. T.	100 00
Anderson Boswell, 116th U. S. C. T	100 00
James R. Weeks, 60th U. S. C. T	100 00
Lindsey Anderson, 60th U. S. C. T.	100 00
Samuel Williams, 31st U. S. C. T	100 00
William Banion, 60th U. S. C. T	100 00
Silas Samuels, 60th U. S. C. T	100 00
Albert Stevenson, 106th U. S. C. T	297 80
Richd. Appleton, 111th U. S. C. T	300 00
Floyd Bryant, 114th U. S. C. T	100 00
William Allen, 110th U. S. C. T	200 00
Robert Henshaw, 83d U. S. C. T	100 00
Samuel Davis, 79th U. S. C. T	100 00
Jacob Smart, 83d U. S. C. T	100 00
James Miller, 39th U. S. C. T	300 00
Jesse Norris, 39th U. S. C. T.	300 00
Benjamin Brunt, 83d U. S. C. T	100 00
Anthony Roberts, 83d U. S. C. T.	100 00
Richard Salter, 116th U. S. C. T	100 00
James H. Johnson, 23d U. S. C. T.	100 00
Charles Alexander, 13th U. S. C. H. A	100 00
Joseph Birdsong, 1st U. S. C. Cav	100 00
Ridley Walker, 58th U. S. C. T	100 00
Anderson Coulter, 40th U. S. C. T	100 00
Hezekiah Patrick, 17th U. S. C. T	100 00
Elias Broady, 89th U. S. C. T	100 00
Lewis Holmes, 87th U. S. C. T	100 00
Henry Davis, 109th U. S. C. T.	100 00
Thomas Bowlin, 92d U. S. C. T	100 00
Thomas Brown, 76th U. S. C. T.	100 00
James Monton, 78th U. S. C. T.	100 00
Robert Patterson, 84th U. S. C. T	100 00
General Carroll, 101st U. S. C. T	300 00
Dock Staley, 40th U. S. C. T	300 00
Samuel Bayard, 6th U. S. C. T	100 00
Squire Route, 123d U. S. C. T	100 00
Joseph Wilson, 79th U. S. C. T	100 00
Daniel Ramsey, 63d U. S. C. T	100 00
James Brawley, 60th U. S. C. T	100 00
Elijah Burrows, 64th U. S. C. T	100 00

Schedule of claims, &c.—Continued.

Cato Johnson, 97th U. S. C. T	$200 53
Adam Myers, 76th U. S. C. T	100 00
Henry Mack, 87th U. S. C. T	100 00
John Duncan, 107th U. S. C. T	100 00
Alfred Mitchell, 96th U. S. C. T	100 00
James Isaacs, 84th U. S. C. T	100 00
Allen Bell, 52d U. S. C. T	100 00
James Stewart, 75th U. S. C. T	100 00
Charles Ward, 17th U. S. C. T	100 00
George Hamilton, 6th U. S. C. T	300 00
Jacob Harlin, 1st U. S. C. T	100 00
Milton Oendorf, 12th U. S. C. T	100 00
Alexander Brown, 13th U. S. C. T	100 00
Festus White, 9th U. S. C. T	200 00
Frank Casey, 14th U. S. C. T	91 20
Mitchell Wynn, 17th U. S. C. T	100 00
Felix Cullom, 17th U. S. C. T	100 00
Peter Alston, 40th U. S. C. T	100 00
John Stokes, 52d U. S. C. T	300 00
James Knave, 17th U. S. C. T	100 00
Jas. B. Delaney, 29th U. S. C. T	140 00
Dick Williams, 64th U. S. C. T	260 00
Frederick Shields, 52d U. S. C. T	100 00
Jerry Hays, 58th U. S. C. T	100 00
Burl Head, 64th U. S. C. T	25 00
Alford White, 11th U. S. C. H. A	100 00
Roach Turner, 11th U. S. C. T	100 00
Phillip McCrary, 13th U. S. C. T	100 00
James McClees, 37th U. S. C. T	290 00
John A. Scott, 29th Conn	300 00
John Capehart, 1st Ky. Cav	100 00
Edwin S. Sloan, 2d Mo. S. M	100 00
James Beale, 22d Mo. Vols	100 00
Lorin S. Bodelle, 22d V. R. C	300 00
George F. Green, 5th Tenn. Cav	200 00
Henry Wilson, 4th Ky. Vols	110 57
Thomas Hereld, 17th Ky. Cav	33 34
Porter H. Calbert, 11th Ky. Vols	100 00
Louis Price, 2d Mo	100 00
George W. Prater, 14th Ky	75 00
Andrew J. Salsman, 27th Ky	100 00
Jacob T. Bask, 22d Ky	100 00
John Holloway, 2d Tenn	100 00
Lewis E. Musick, 13th Mo. Cav	100 00
William G. Anderson, 8th Mo. Cav	240 00
Charles O. King, 16th V. R. C	75 00
William S. Kleckner, 8th Mo	100 00
James F. Farrar, 11th Mo. Cav	200 00
William Wiant, 5th M. S. M	100 00
William R. Young, 7th M. S. Cav	100 00
Jacob Lano, 2d V. R. C	165 00
William Johnson, 10th Ky	100 00
David F. Cress, 2d M. S. M. C	100 00
William H. Purcell, 39th Ohio and 18th Ky	200 00
Henry Voorhies, 2d V. R. C	325 00
John W. Curtis, 1st M. S. M	100 00
Calvin Holston, 5th Tenn. Cav	75 00
Charles Street, 4th Mo. Cav	100 00
John Gallop, 9th M. S. M. Cav	100 00
Jones C. Molter, 19th V. R. C	75 00
William L. McCannon, 10th Tenn	100 00
Jeremiah McCoy, 45th U. S. C. T	17 19
George Lawler, 115th U. S. C. T	100 00
William Butler, 7th U. S. C. T	100 00
Lewis Boughton, 12th Pa. Res	465 00
Calvin Russell, 46th U. S. C. T	100 00

Schedule of claims, &c.—Continued.

Victor Johnson, 73d U. S. C. T	$100 00
Monroe Walker, 5th U. S. C. H. A	100 00
David Simeon, 81st U. S. C. T	100 00
Daniel Spriggs, 5th U. S. C. H. A	100 00
Geo. W. Ulsh, 1st Pa. Prov. Cav	160 00
Gustav Sells, 15th Kan. Cav. and 1st Kan. Vols	400 00
Dudley H. Pepper, Miss. Marine Brigade	50 00
Jas. S. Mullen, Miss. Marine Brigade	75 00
Eli Gardner, 104th N. Y	100 00
John B. Markley, 9th Mich	100 00
Wm. Dunlap, 145th Pa	75 00
Aaron Young, 6th N. Y. H. Art	75 00
John W. Sage, 114th N. Y	66 67
H. E. Brainerd, 5th N. Y. Cav	100 00
Stephen Bush, 16th N. Y. Art	75 00
R. J. Austin, 6th Mich. Cav	40 00
Jacob Freas, 2d N. J. Cav	100 00
Thos. Cuthbertson, 1st Mich. Cav	100 00
Samuel A. Davis, 8th Pa. Res	100 00
John T. Drouenberg, 1st P. H. B. Md. Cav	100 00
Wm. Doyle, 11th N. Y	100 00
Ithamer Jenner, 11th N. Y	100 00
Decatur Childs, 8th Mich. Cav	33 34
Jeremiah Bittner, 87th Pa	100 00
Hiram W. Frazee, 2d Ky. Art	100 00
John Angel, 15th Iowa	100 00
John P. Decker, 13th N. Y	75 00
Chas. J. Palmer, 144th N. Y	75 00
Geo. Slater, 128th N. Y	75 00
Jos. H. Marple, 11th Kan	75 00
Wm. J. Pierce, 9th N. Y. Art	75 00
Wm. E. Burlew, 109th N. Y	75 00
John Burrows, 5th Pa. Cav	290 00
Chester Kemp, 1st Mich. S. S	240 00
Peter Lowry, 10th Pa. Res	100 00
A. McKevit, (alias J. Burk,) 90th Pa	100 00
J. J. Leis, (alias L. Marsch,) 58th N. Y	200 00
Michael O'Neill, 11th N. Y	100 00
Jas. A. Austin, 1st Mich. S. S	85 00
Jas. S. Kiffington, 2d N. Y. Art	48 00
Franklin Saul, 183d Pa	100 00
Joshua Adamson, 39th Iowa	75 00
Allen Delezon, 8th Mich. Cav. and 4 Mich. Vols	175 00
Simeon Bradley, 2d Pa. Prov. Cav	233 60
W. H. Baldwin, 2d Pa. Heavy Art	100 00
Jerre Burger, 6th Pa. Res	100 00
Abel Cruson, 2d Mich. Cav	100 00
Sam. H. Blackman, 89th N. Y	100 00
George Eggers, 11th N. Y	100 00
Richard Wilson, 11th N. Y	100 00
W. L. Eggleston, 64th N. Y	100 00
Anson Freeman, 10th Minn	100 00
Samuel Cady, 74th N. Y	100 00
T. C. Eastley, 1st N. Y. Cav	100 00
J. H. Franklin, 6th N. Y. Art	100 00
R. Goodspeed, 8th Mich. Cav	100 00
Hiram E. Gruber, 8th Mich. Cav	120 00
Richard Green, 71st N. Y	100 00
Perry A. Goodall, 93d N. Y	100 00
Henry H. Hamilton, 1st N. Y. Prov. Cav	100 00
William Hogle, 9th Mich. Vols	50 00
Anderson Hurst, 2d Iowa Vols	100 00
Joseph Kennessy, 8th N. Y. Heavy Art	100 00
Hiram C. Fulton, 2d N. Y. Cav	40 00
William E. Helmer, 7th Mich. Vols	100 00
James Heany, 11th N. Y. Vols	100 00

Schedule of claims, &c.—Continued.

Sam. L. Jones, 30th Mich. Vols	$33 33
John Krieg, 74th N. Y. Vols	50 00
Levi Lackey, 209th Pa. Vols	66 67
J. J. Lautz, 52d Pa. Vols	100 00
Charles Lyon, 190th Pa. Vols	115 00
Ivory Lambert, 31st Iowa Vols	25 00
C. C. Howe, 52d Pa. Vols	100 00
Henry Hayden, 23d N. Y. Battery	300 00
W. H. Mast, 2d Pa. Art	100 00
Harrison Morse, 5th N. Y. Cav	100 00
E. D. Conley, 6th Mich. Art	100 00
John Kilbourn, 3d Mich. Cav	33 33
Phineas Malin, 13th Pa. Res	100 00
William E. Martin, 3d Mich. Cav	200 00
Benjamin Mathews, 6th Iowa Vols	240 00
Pat. McNany, 22d N. Y. Cav	92 38
John S. Penrod, 76th Pa. Vols	100 00
John Quirk, 6th Cal. Vols	300 00
N. M. Richardson, 2d Mich. Vols	200 00
John Rhinehart, 13th Pa. Res	100 00
John Rhinehart, 12th Pa. Cav	300 00
C. W. Yoxtheimer, 53d Pa. Vols	290 00
Dan. Shiers, 98th Pa. Vols	162 03
W. F. Russell, 12th Pa. Cav	100 00
John A. Smith, 111th Pa. Vols	100 00
Paul Smith, 188th Pa. Vols	45 00
John Slugg, 4th Pa. Res	100 00
Ansell Adams, 27th Mass. Vols	100 00
S. Buchanan, 40th Ohio Vols	30 90
John P. Bishop, 64th Ill. Vols	80 00
John W. Byers, 15th Ill. Cav	240 00
Chas. Brown, 149th Ill. Vols	75 00
A. L. Brown, 12th Iowa Vols	120 00
John J. Bray, 1st N. J. Cav	75 00
Angelo Burke, 5th Ohio Cav	190 00
H. Chronister, 89th Ind. Vols	75 00
F. E. Curtis, 7th Wis. Vols	100 00
Francis Cahill, 4th N. H. Vols	100 00
Charles Curtis, 15th Ill. Vol	100 00
T. P. Carlin, 3d Vt. Vols	100 00
E. Cawood, 150th Ind. Vols	33 33
E. Crupper, 1st Ohio Cav	100 00
J. L. Coffin, 4th Wis. Vols	100 00
P. DeWolf, 9th Ill. Cav	100 00
Levin Dodds, 18th Wis. Vols	100 00
Carlos Duvall, 1st Vt. Cav	100 00
R. H. Dinehey, 1st Conn. Heavy Art	100 00
R. Deutschman, 3d Ohio Cav	100 00
Russell Delap, 23d Wis. Vols	75 00
J. W. Densmore, 69th Ind. Vols	75 00
E. P. Elsbree, 7th Mass. Vols	100 00
A. J. Florey, 8th Ill. Vols	300 00
J. S. Favis, 50th Ill. Vols	100 00
Sam. B. Fisk, 17th Vt. Vols	40 00
Grovey French, 21st Ohio Vols	100 00
Philip French, 32d Ill. Vols	100 00
W. W. C. Groatley, 13th Ind. Cav	75 00
John H. Griffith, 15th Ill. Vols	200 00
Hay Grieve, 107th N. Y. Vols	75 00
H. Glasener, 57th Ill. Vols	100 00
Henry Grieder, 74th Ind. Vols	192 00
A. B. Horton, 103d Ohio Vols	75 00
William Harden, 18th Wis. Vols	100 00
A. J. Hard, 6th Ind. Cav	200 00
P. W. Hensley, 94th Ohio Vols	40 00
H. S. Hodge, 3d Wis. Cav	100 00

Schedule of claims, &c.—Continued.

J. Q. A. Harlow, 32d Mass. Vols	$190 00
Charles Harroun, 12th Ill. Cav	40 00
John Hargis, 15th Ind. Vols	100 00
George S. Hoover, 61st Ohio Vols	100 00
John Houghtaling, 3d Wis. Cav	100 00
M. Hughes, 98th Ill. Vols	75 00
H. E. Holcomb, 7th Wis. Vols	190 00
John Ingold, 37th Ohio Vols	100 00
Thomas James, 13th Ill. Cav	240 00
H. F. Jacobs, 17th Ill. Vols	100 00
George Jenkins, 33d Ill. Vols	300 00
Clouse Johnson, 37th Ill. Vols	100 00
George A. Johnson, 7th Marine Battery	120 00
James T. Kelley, 1st Ind. Cav	100 00
Alex'r Knife, 25th Ill. Vols	100 00
S. W. Keyes, 16th Mass. Vols	100 00
Dan Knauss, 15th Iowa Vols	76 56
Levi Kelly, 5th W. Va. Vols	100 00
Fred Keim, 84th Ill. Vols	75 00
E. Kavanaugh, 39th Ohio Vols	100 00
Thomas Larkin, 43d Ohio Vols	100 00
John Lafayette, 6th Ohio Vols	100 00
I. S. Lane, 16th Ill. Vols	100 00
Scott Looker, 43d Ohio Vols	100 00
John Lipp, 20th Ill. Vols	100 00
Jno. Lyle, 1st W. Va. Cav	100 00
Dan Lloyd, 80th Ohio Vols	290 00
L. Lassiter, 97th Ill. Vols	75 00
D. M. Morris, 33d Ill. Vols	140 00
Henry Mosier, 31st Wis. Vols	80 00
J. H. McKenney, 6th Maine Vols	100 00
Francis Moses, 18th Ohio Vols	100 00
John McDanell, 11th Ohio Cav	120 00
Thos McLarnaer, 6th Co. Ohio S. S	160 00
Geo. W. Miller, 1st Ind. Heavy Art	100 00
Ezekiel Miles, 6th Vermont Vols	100 00
Francis Mets, 11th Ohio Cav	190 00
John Mueller, 9th Ohio Cav	100 00
Sam Gow, 53d Ohio Vols	140 00
F. Z. T. W. Jensen, 13th Ill. Cav	100 00
William Moore, 18th Ill. Cav	100 00
J. R. Muldnner, 26th Ind. Vols	140 00
S. V. Mosher, 2d Ill. Cav	100 00
James McCord, 3d Wis. Cav	100 00
Thos. Mathews, 155th N. Y. Cav	75 00
John E. Moore, 73d Ill. Cav	75 00
William J. Mattingly, 35th Ill. Cav	100 00
A. Montegriff, 39th N. Y. Cav	100 00
Jno. Mathaws, 14th Mich. Cav	80 00
B. Moy, 82d Ohio Cav	100 00
W. McGuire, 2d Iowa Cav	100 00
S. N. Neblack, 12th Ill. Cav	165 00
F. Napper, 15th Ill. Cav	82 50
H. B. Nichols, 11th Maine Vols	100 00
Lucius Nash, 39th Ill. Vols	100 00
S. G. Nories, 22d Ohio Vols	100 00
Martin Nelson, 5th Ind. Cav	100 00
J. Nicholson, 9th Ohio Vols	100 00
Uri Oren, 147th Ind. Vols	33 33
Thos. O'Brien, 3d Ohio Cav	45 00
N. F. Orem, 10th Ohio Cav	75 00
Walter Palmer, 6th Conn. Vols	100 00
James Pierce, 46th Ill. Vols	100 00
James Parker, 1st Ind. Heavy Art	200 00
G. H. Phelps, 6th Wis. Vols	100 00
J. E. Perkins, 3d Mich. Vols	100 00

Schedule of claims, &c.—Continued.

Geo. Palmerston, 1st Wis. Vols	$100 00
Philip Rizer, 150th Ind. Vols	33 33
H. C. Reed, 5th Ill. Cav	100 00
J. H. B. Renfro, 48th Ill. Vols	124 86
J. R. McMurtry, 56th Ill. Vols	100 00
B. S. McMurtry, 56th Ill. Vols	100 00
B. F. Chandler, 29th Ind. Vols	100 00
John Rickley, 157th Ill. Vols	24 29
Charles C. Robbins, 1st Ind. Heavy Art	300 00
John Reynolds, 73d Ohio Vols	100 00
Daniel Webster, 3d Vermont Vols	82 98
Thomas Smith, 17th Mass. Vols	100 00
Frank Partridge, 1st Mass. Vols	100 00
James Cain, 62d Pa. Vols	100 00
George Grinnell, 6th Pa. Res	100 00
Albert Phillips, 23d Ill. Vols	100 00
W. V. Riggins, 22d Ill. Vols	100 00
T. A. Millhouse, 14th Ill. Vols	100 00
Gilman Chase, 15th Ill. Vols	100 00
B. F. Beck, 8th Ill. Vols	100 00
William Darragh, 26th Ill. Vols	100 00
C. C. Shobe, 6th Iowa Vols	100 00
Adam Clark, 23d Ind. Vols	100 00
F. M. Walters, 17th Ind. Vols	100 00
W. L. Bronson, 5th Wis. Vols	100 00
J. D. Graff, 25th Ohio Vols	100 00
Andrew Tailor, 8th Ohio Vols	100 00
W. C. Suff, 24th Ohio Vols	100 00
J. B. Davis, 5th Ohio Vols	100 00
Merserean Wood, 67th N. Y. Vols	100 00
George Barrett, 1st Conn. Art	100 00
J. G. Shaw, 3d Wis. Vols	100 00
S. H. Hagadora, 1st Wis. Art	100 00
A. W. Rose, 14th Ind. Art	100 00
William McCoubrey, 79th N. Y. Art	100 00
W. W. Brodie, 40th N. Y. Art	100 00
L. W. Callaghan, 40th N. Y. Art	100 00
James Kirkman, 6th U. S. Cav	200 00
Chas. Stafford, 1st N. Y. Cav	100 00
C. N. Case, 15th Ill. Vols	100 00
E. T. Bristol, 84th N. Y. Vols	100 00
Henry Cowles, 13th Pa. Res	100 00
Charles Parker, 3d Mich. Vols	100 00
C. G. Beales, 5th Iowa Vols	100 00
W. A. Critchfield, 23d Ohio Vols	100 00
J. W. Johnson, 10th Ill. Vols	93 70
John Samms, 21st Ill. Vols	64 06
B. D. Ketts, 14th Ill. Vols	100 00
J. H. Shoemaker, 26th Ind. Batty	100 00
D. D. Daily, 1st Mich. Lt. Art	100 00
Hazelton Saunders, 1st Mich. Inf	100 00
H. C. Schney, 62d Pa	100 00
E. H. Slocum, 11th N. Y	100 00
Silas Osborn, 50th N. Y. Engrs	100 00
William Rose, 3d Ohio Cav	100 00
Walter H. White, 50th N. Y. Engrs	100 00
James C. Armor, 101st Pa	240 00
Wm. A. York, 25th Wis	75 00
Total	50,951 82

NOTE.—(*By Second Auditor's Office.*)—The sixty-one bounty claims marked (*) have been certified by this office and confirmed by the Second Comptroller. The remaining bounty claims have been certified by this office and are now in the Second Comptroller's office awaiting confirmation.

Schedule of claims, &c.—Continued.

ARMY TRANSPORTATION, 1871 AND PRIOR YEARS.—(For reappropriation.)

No. of claim.	Name of claimant.	No. of sett.	Date.	Amount.
20,378	Illinois Central Railroad Company	2070	Jan. 16, 1877	$355 63
40,567	John Dowling, ($84 20 paid)	2084	Jan. 16, 1877	315 80
42,104	H. B. Guthrie	2101	Jan. 17, 1877	200 00
41,299	J. T. Bell	2108	Jan. 18, 1877	187 50
25,762	Jourden Peacock	2125	Jan. 19, 1877	171 50
38,703	Wm. H. McAtee	2132	Jan. 19, 1877	229 97
41,973	Jefferson Jones	2138	Jan. 19, 1877	39 75
33,744*	Elizabeth Jane Wirthlin and fourteen others	2173	Jan. 24, 1877	2,730 48
13,202	Steamer "J. D. Swain" and Edwin E. Sanderson	2174	Jan. 24, 1877	6,850 00
40,301	Baltimore and Ohio Railroad Company	2238	Feb. 8, 1877	15,228 93
40,485	Sloop "Pointer" and owner	2248	Feb. 8, 1877	161 00
38,748	Wesley Rhodes	2250	Feb. 8, 1877	90 00
40,031	Joseph F. Dunn	2263	Feb. 10, 1877	73 75
42,067	George Pollock	2272	Feb. 12, 1877	2 00
42,785	A. H. Kennedy	2278	Feb. 13, 1877	8 75
42,787	Z. Lindsay	2279	Feb. 13, 1877	42 50
42,786	Frank Skillem	2299	Feb. 14, 1877	60 50
40,872	W. T. Anthony	2301	Feb. 15, 1877	210 00
39,570	Wm. C. Lafferry	2381	Feb. 26, 1877	705 50
42,635	P. V. Johns	2386	Feb. 26, 1877	10 50
27,319	John Oden	2437	Mar. 9, 1877	365 25
38,551	David Gibson	2488	Mar. 15, 1877	270 00
41,980	Ellsworth P. Scales, (in part,) Second Comptroller's settlement	2661	Mar. 23, 1877	565 00
42,216	Robert Kinningham	3503	April 14, 1877	33 00
40,609	R. D. McCracken	3518	April 17, 1877	135 95
42,105	Mary W. May	3519	April 17, 1877	72 50
42,200	Jesse Cheek and Stephen Dark, executors, &c	3517	April 17, 1877	39 06
40,376	George Johnson	3526	April 17, 1877	160 00
43,988	Wm. A. Walker	3541	April 18, 1877	8 40
38,241	George La Rochelle	3546	April 18, 1877	114 50
42,932	George Gillespie, deceased	3597	April 21, 1877	79 37
42,149	Theo. A. Fisk, deceased	3601	April 23, 1877	75 00
39,031	Daniel McGuiney	3602	April 23, 1877	86 00
43,984	Frank Skillem	3604	April 23, 1877	27 56
42,899	T. J. Moore and seven others, (in part)—Jno. Henderson	3620	April 25, 1877	5 00
43,964	August Thieman	3670	May 2, 1877	15 00
32,863	William Bradford	3678	May 3, 1877	180 00
42,314	Kitty C. Sims, deceased	3684	May 3, 1877	155 50
42,737	James L. Coman	3688	May 3, 1877	62 75
25,897	Hugh J. Conby	3696	May 4, 1877	80 00
44,024	P. W. Cargile	3699	May 4, 1877	8 25
41,071	Mrs. Fanny Harding, (in part)	3706	May 4, 1877	540 00
	Outstanding liabilities, (transfer settlement)	3691	May 4, 1877	93 37
43,664	A. R. Alley	3725	May 7, 1877	17 18
42,069	John McCroskey, deceased	3773	May 11, 1877	443 00
42,035	T. P. Clement	3768	May 11, 1877	250 00
42,077	Hardin R. Wright and one other	3788	May 12, 1877	15 00
	Union Pacific Railroad Company	7409	Mar. 28, 1874	2,000 00
44,036	P. E. Freeman, (Second Comptroller's statement)	3822	May 25, 1877	110 00
39,173	Ezekiel A. Neal	3835	May 28, 1877	103 25

* And others.

Schedule of claims, &c.—Army transportation, 1871 *and prior years*—Continued.

No. of claim.	Name of claimant.	No. of sett.	Date.	Amount.
32,432	George Thomas, (in part)	3842	May 28, 1877	$15 00
42,934	James Whitworth, (in part)	3843	May 28, 1877	230 00
42,899½	Daniel S. Tucker	3854	May 29, 1877	200 00
40,097	J. B. Pickens	3892	June 2, 1877	125 00
43,995	Emanuel Snyder	3948	June 5, 1877	28 00
38,174	Mrs. Nancy Butler, (in part)	3898	June 4, 1877	125 00
40,113	J. C. Bryan	3901	June 4, 1877	75 00
25,357	Wm. L. Fenix	3921	June 4, 1877	5 00
38,928	Meh-ha-ke	3936	June 5, 1877	31 00
39,784	Valentine Cleck	4010	June 7, 1877	71 75
25,381	Henderson Moore	4035	June 9, 1877	90 00
39,394	G. W. Moore	4038	June 9, 1877	72 49
37,486	J. M. Symons	4039	June 9, 1877	11 00
40,480	Estate of Owen Murray	3942	June 5, 1877	121 32
44,267	Gabriel Smith	4079	June 14, 1877	32 37
32,035	J. Condit Smith	4146	June 25, 1877	670 00
44,074	Annapolis and Elk-Ridge Railroad Company	4173	June 29, 1877	99 27
	S. S. Van Vliet, Captain and A. Q. M., (settlement by Quartermaster's Div.)	4262	July 24, 1877	100 00
42,946	James Cox	4341	Aug. 9, 1877	44 06
44,161	Fanny Harding, (E. D. Hicks, executor)	4358	Aug. 9, 1877	243 36
39,561	Peter McClusky	4362	Aug. 9, 1877	50 00
42,145	Baltimore and Ohio Railroad Company	4355	Aug. 9, 1877	439 34
43,958	Baltimore and Ohio Railroad Company	4351	Aug. 9, 1877	23,133 29
23,068	Fitchburg Railroad Company	4381	Aug. 9, 1877	268 03
33,869	R. K. Young, (part under Q. M. Division, 1871, and prior)	4387	Aug. 9, 1877	16 00
12,817	William Lincoln, ($28 under Q. M. Division, 1871, and prior)	4417	Aug. 15, 1877	2 00
	Richard A. Osmar, late Lieutenant 2d Cavalry, (settlement made by Q. M. Division)	4447	Aug. 20, 1877	43 85
43,656	John H. Jackson	4496	Sept. 1, 1877	156 00
42,124	Louis Brown	4528	Sept. 8, 1877	129 90
38,673	Godfrey Nave, (or Knave)	4535	Sept. 8, 1877	66 00
40,165	E. W. Murphy, (steam ferry-boat "Wide Awake")	4571	Sept. 17, 1877	100 00
44,935	H. B. North	4597	Sept. 28, 1877	199 00
44,515	Acher H. Farmer	4627	Oct. 9, 1877	110 00
44,825	Wm. T. Price	4637	Oct. 9, 1877	14 50
38,311	Central Vermont Railroad Company	4573	Sept. 22, 1877	4 02
40,336	Margaret Voigt, widow of B. Voigt	4598	Sept. 28, 1877	108 00
26,387	Sinclair Garvin, deceased (J. W. Edwards, executor)	4629	Oct. 9, 1877	60 00
38,610	D. J. Perin, widow of E. Perin, (or Parien)	4638	Oct. 9, 1877	39 00
38,635	Richard Taylor	4668	Oct. 12, 1877	63 00
38,674	Henry Dickinson			22 00
44,011	James Wilson	4703	Oct. 15, 1877	123 75
42,102	J. P. Maxwell, father of C. O. Maxwell	4690	Oct. 15, 1877	12 00
34,766	Buffalo and Erie Railroad Company, (payment to Lake Shore and Michigan Southern Railroad Company)	8657	Jan. 31, 1876	48
31,202	John P. Brown	4736	Oct. 22, 1877	735 00
42,118	Wm. J. Carter	4804	Nov. 10, 1877	58 32
43,426	Robert Rhinehart	4814	Nov. 10, 1877	76 90
44,965	John Howard	4809	Nov. 10, 1877	52 50
45,168	Annapolis and Elk-Ridge Railroad Company	4827	Nov. 13, 1877	7 78
44,785	Baltimore and Ohio Railroad Company	4832	Nov. 13, 1877	539 42

Schedule of claims, &c.—Army transportation, 1871 *and prior years.*—Continued.

No. of claim.	Name of claimant.	No. of sett.	Date.	Amount.
44,784	Baltimore and Ohio Railroad Company..	4833	Nov. 13, 1877	$171 00
44,301	Annapolis and Elk-Ridge Railroad Company	4881	Nov. 15, 1877	14 76
40,875	Steam-tug "Columbus," (Jos. McLean, owner)	4898	Nov. 20, 1877	12,250 00
45,180	Annapolis and Elk-Ridge Railroad Company	4922	Nov. 24, 1877	1,341 22
37,481	Mobile and Montgomery Railroad Company; (by oversight this item was omitted to be entered and included in the report made to Secretary of War December 19, 1876; $144 62 was paid at time of settlement, leaving still due, $22 13)	7973	Oct. 30, 1875	22 13
29,776 29,778	Mrs. Marina Douglas, ($130 under C. and A. horses, 1871)	4935	Nov. 26, 1877	60 00
43,982	Steplen Nickerson, (schooner "H. P. Russell")	4989	Nov. 28, 1877	100 00
45,350	John Waldron, deceased, (John Jones, executor)	4943	Nov. 26, 1877	422 00
44,938	F. A. Westmoreland	4921	Nov. 23, 1877	45 00
45,325	Baltimore and Susquehanna Steam Company, (tug "Atlas")	5044	Dec. 6, 1877	321 50
28,550	Central Pacific Railroad Company, $46 03; Union Pacific Railroad Company, $28 03	5095	Dec. 12, 1877	74 06
18,005	A. Buchanan, (barge "Storm No. 3")	5113	Dec. 15, 1877	1,666 67
31,425	Jack Foster, deceased, $92; Joseph Blair, deceased, $117 50; Morris Pettit, deceased, $35, (by Worcester Willey, administratrix)	5128	Dec. 17, 1877	244 50
10,832	Steam-propeller "Eclipse"	5135	Dec. 17, 1877	652 50
45,247	W. S. Cardwell	5117	Dec. 15, 1877	190 46
45,310	John Griffin, deceased, (Charity Griffin, administratrix)	5131	Dec. 17, 1877	236 00
17,129	Thos. H. Halsey	5142	Dec. 18, 1877	73 60
44,118½	Augustus Kernan	5150	Dec. 18, 1877	61 25
45,049	G. L. Hammond	5144	Dec. 18, 1877	60 00
45,516	Annapolis and Elk-Ridge Railroad Company	5139	Dec. 18, 1877	1,114 28
38,602	M. D. Lyles	5153	Dec. 19, 1877	26 00
43,425	Mrs. R. H. Moore	5162	Dec. 19, 1877	129 00
29,327	Benj. Mills	5164	Dec. 19, 1877	155 00
38,614	David Prater	5172	Dec. 19, 1877	34 50
34,394	Geo. Starks; Inskep & Co.; Donelly, Skiner & Co	5177	Dec. 19, 1877	99 50
40,695	A. Walker	5184	Dec. 19, 1877	14 00
38,629	J. R. Wooten	5186	Dec. 19, 1877	34 00
24,944	Morris L. Bond	5200	Dec. 20, 1877	150 00
42,783	Sam'l Hawkins	5210	Dec. 21, 1877	60 75
44,845	Lieut. Henry Romeyn	5227	Dec. 22, 1877	93 10
38,158	William C. Hennegar	5260	Dec. 28, 1877	250 00
	Total			82,969 93

Schedule of claims, &c.—Continued.

ARMY TRANSPORTATION, 1874.—(For reappropriation.)

No. of claim.	Name of claimant.	No. of sett.	Date.	Amount.
41,405	Union Pacific Railroad Company, (in part)	2157	Jan. 22, 1877	$3,993 69
42,043	Sioux City and Pacific Railroad Company	2333	Feb. 20, 1877	344 46
42,312	Atchison, Topeka, and Santa Fé Railroad	3743	May 8, 1877	22 84
43,950	Henry C. Lovell	3769	May 11, 1877	407 47
42,036	Sioux City and Pacific Railroad Company	2291	Feb. 14, 1877	165 50
44,038	Missouri, Kansas, and Texas Railway Company	3867	May 29, 1877	23 74
44,112	Texas and Pacific Railroad Company, (in part)	3853	May 29, 1877	254 20
40,480	Estate of Owen Murray	3942	June 5, 1877	25 00
42,857	Union Pacific Railroad Company	3662	April 30, 1877	490 94
42,859	Union Pacific Railroad Company	3745	May 8, 1877	872 86
42,861	Union Pacific Railroad Company	3663	May 1, 1877	646 82
42,024	Central Pacific Railroad Company	3727	May 7, 1877	6 50
44,291	Union Pacific Railroad Company	4259	July 23, 1877	597 56
42,860	Union Pacific Railroad Company, (part under 1875)	4204	July 9, 1877	46 35
38,489	Steamer "Mississippi"	4368	Aug. 9, 1877	78 30
44,471	Atlantic and Pacific Railroad, (lessee of Missouri Pacific Railroad Company)	4352	Aug. 9, 1877	99 72
44,292	Union Pacific Railroad Company, (A. T. 1875, $36,421 31; A. T. 1876, $5,130 84)	4567	Sept. 14, 1877	8,542 93
44,313	Virginia and Truckee Railroad Company, (amount allowed, $192; residue is under 1873, '75, '76)	4589	Sept. 28, 1877	60 00
44,366	Union Pacific Railroad Company, (amount of settlement, $40,619 63; the balance, is under 1875 and 1876)	4592	Sept. 28, 1877	89 06
33,063	Central Vermont Railroad Company, ($35 82 under 1873)	4724	Sept. 18, 1877	2 75
45,148	Atlantic North Carolina Railroad Company, ($18 40 under 1875)	4761	Oct. 27, 1877	6 80
44,170	Union Pacific Railroad Comp'y, ($5,994 52 under 1875)	4799	Nov. 10, 1877	23,764 98
45,363	Atchison, Topeka, and Santa Fé Railroad Company	5082	Dec. 11, 1877	170 06
	Total			40,712 53

BARRACKS AND QUARTERS, 1872.—(For reappropriation.)

44,679	J. F. Wade, ($54 88, under Quartermasters' department, 1872)	4465	Aug. 22, 1877	$268 80

BARRACKS AND QUARTERS, 1873.—(For reappropriation.)

38,323	M. V. Plank, U. D. Ostrander, Thomas Harvey, and G. A. Lubert, ($435 50 each)	2423	March 8, 1877	$1,742 00

Schedule of claims, &c.—Continued.

BARRACKS AND QUARTERS, 1874.—(For reappropriation.)

No. of claim.	Name of claimant.	No. of sett.	Date.	Amount.
35,962	George W. Hutchings	3858	May 29, 1877	$30 00

REGULAR SUPPLIES, QUARTERMASTERS' DEPARTMENT, 1871 AND PRIOR YEARS.—(For reappropriation.)

No. of claim.	Name of claimant.	No. of sett.	Date.	Amount.
40,472 27,783 27,907	W. D. Flanegan	1938	Dec. 19, 1876	$26 10
39,562	Wesley Goodin, administrator of Ambrose Goodin	2016	Jan. 11, 1877	125 00
40,321	G. W. Williams	2031	Jan. 12, 1877	24 00
40,487	Thomas Digges	2037	Jan. 13, 1877	15 40
42,209	Hiram Harkins	2046	Jan. 13, 1877	25 00
38,250	Mrs. D. Codey	2061	Jan. 15, 1877	33 75
32,300	W. G. Colier	2062	Jan. 15, 1877	7 50
42,104	H. B. Guthrie, (in part)	2101	Jan. 17, 1877	70 00
42,486	John P. Bane	2107	Jan. 18, 1877	214 28
39,233	Absalom Robinson	2118	Jan. 19, 1877	475 00
40,050	D. C. Oates	2119	Jan. 19, 1877	90 00
38,761	Margaret J. Garvin	2139	Jan. 19, 1877	32 00
41,678	J. B. Bowling and one other	2150	Jan. 20, 1877	277 25
40,700	William Hawkins	2151	Jan. 20, 1877	7 00
40,921	James Harrison	2152	Jan. 20, 1877	15 00
39,634	William Seigmund, (in part)	2158	Jan. 22, 1877	42 63
40,322	D. T. Herrod, administrator, &c	2201	Jan. 29, 1877	30 00
28,824	Francis Jackson	8328	Dec. 4, 1875	139 00
42,100	Charles H. Primm	2271	Feb. 12, 1877	9 00
40,698	Granville S. Pierce	2277	Feb. 13, 1877	87 50
34,873	Thomas Veal	2284	Eeb. 13, 1877	130 36
40,650	John S. Dodd	2304	Feb. 15, 1877	15 00
39,225	James I. Elliott, deceased	2305	Feb. 15, 1877	60 00
35,693	Amos Hall	2308	Feb. 15, 1877	7 00
40,433	Alexander Monroe	2311	Feb. 15, 1877	18 25
41,934	John W. Rokenbough	2336	Feb. 20, 1877	16 00
30,410	G. W. Atkins	2337	Feb. 21, 1877	30 00
35,882	William Bottom	2338	Feb. 21, 1877	41 50
30,669	Presley and Jas. Morehead	2341	Feb. 21, 1877	128 86
25,396	A. T. Stokes	2349	Feb. 22, 1877	85 50
40,362	Geo. A. McClanahan and one other	2357	Feb. 21, 1877	85 00
40,470	Orvil Vineyard	2367	Feb. 23, 1877	137 00
39,249	Thomas Glascock, administrator, &c., (Second Comptroller's statement)	2390	Feb. 27, 1877	92 50
25,968	John Purcell	2392	Feb. 27, 1877	14 85
35,515	D. M. Cleggett	2393	Feb. 27, 1877	18 25
38,779	Jacob C. Gove, adm'r of J. P. Gove	2404	Mar. 7, 1877	372 62
31,290 32,110	K. Jameson	2408	Mar. 7, 1877	96 70
38,004	R. B. Lyle, administrator of J. R. Lyle	2409	Mar. 7, 1877	115 40
40,020	James Mitchell	2410	Mar. 7, 1877	36 00
42,877	Joseph Moore	2411	Mar. 7, 1877	31 50
27,955	John McMiller	2413	Mar. 7, 1877	44 85
40,955	James Ryon	2414	Mar. 7, 1877	11 00
42,870	Andrew Brock	2416	Mar. 8, 1877	25 00
40,575	John Hunt	2425	Mar. 8, 1877	28 56
40,535	H. C. Massey	2426	Mar. 8, 1877	29 00
41,872	W. R. Dickerson	2447	Mar. 10, 1877	120 00

Schedule of claims, &c.—Regular supplies, Quartermasters' department, 1871 and prior years—Continued.

No. of claim.	Name of claimant.	No. of sett.	Date.	Amount.
40,715	Abraham Wilder	2450	Mar. 10, 1877	$25 00
	Alexander Grant, Lt. 8th Cav., (Bookkeeper's settlement)	2443	Mar. 10, 1877	129 56
41,980	Ellsworth P. Scales, (in part,) Second Comptroller's settlement	2661	Mar. 23, 1877	550 00
	J. A. P. Hampson, Capt. 10th Inf., (Bookkeeper's settlement)	3133	Apr. 2, 1877	100 00
26,920	W. M. Fish	3495	Apr. 14, 1877	7 50
40,115	Lawrence Keller	3504	Apr. 14, 1877	56 00
39,446	Wm. McConnell	3521	Apr. 17, 1877	322 00
41,941	Lorena Martin	3522	Apr. 17, 1877	15 00
40,870	Benjamin Taylor	3548	Apr. 18, 1877	18 20
42,896	W. R. Taylor	3549	Apr. 18, 1877	27 50
42,184	Irvine P. Walker	3554	Apr. 18, 1877	18 00
42,727	Adam Dodd and five others	3557	Apr. 19, 1877	205 50
40,569	Samuel Scott	3603	Apr. 23, 1877	40 00
42,899	T. J. Moore and seven others, (in part)—J. W. Vinson, S. M. Mort, J. A. Burton, Hugh Allen, G. M. D. Stoner, John Weatherspoon, Jno. Henderson	3620	Apr. 25, 1877	267 35
42,931	Jas. Whitworth, executor of Thomas Bysor, deceased	3622	Apr. 25, 1877	105 00
38,497	Mr. Morcen	3664	May 2, 1877	4 12
26,820	Clark M. Tompkins	3669	May 2, 1877	30 00
27,816	John E. Winn	3672	May 2, 1877	86 00
27,654	Mrs. Nancy Wynne	3673	May 2, 1877	69 50
41,402	Zachariah Taylor, deceased	3674	May 2, 1877	228 80
44,014	George Boyd, deceased	3677	May 3, 1877	87 50
39,350½	R. B. Bacon & Co $20 44	3681	May 3, 1877	39 44
39,351	John Agnew 19 00			
44,006	John H. Stevens	3685	May 3, 1877	170 00
42,081	Gideon E. Coates	3687	May 3, 1877	110 00
30,693	Peter Fer	3700	May 3, 1877	66 88
38,550	E. A. Fletcher	3701	May 4, 1877	337 50
27,630	Thomas Gallaher	3702	May 4, 1877	45 00
27,634	John Hobbs	3705	May 4, 1877	22 50
39,991	H. P. Barner	3726	May 7, 1877	17 50
42,822	William Caskey	3729	May 7, 1877	25 00
38,248	Sam'l A. Caldwell	3730	May 7, 1877	11 25
38,952	James Foster	3733	May 7, 1877	16 00
42,733	Joseph Golatt	3734	May 7, 1877	18 25
38,796	John Horn	3735	May 7, 1877	20 00
12,905	Thomas E. Quisenberry and two others	3741	May 7, 1877	127 35
42,186	D. B. Merrill	3774	May 11, 1877	3 00
42,187	Baltimore and Ohio Railroad Company, (in part)	3767	May 11, 1877	56 28
34,108	Thomas Smith	3777	May 12, 1877	58 00
42,131	Nancy Webb	3787	May 12, 1877	12 00
39,559	S. M. Allen	3791	May 12, 1877	247 20
33,028	W. H. Bradford	3792	May 12, 1877	7 87
42,029	Moses Bell	3826	May 28, 1877	82 40
26,856	John M. Chyster	3827	May 28, 1877	21 67
26,854	John Glass	3829	May 28, 1877	75 00
40,226	Isaac Gray	3830	May 28, 1877	104 50
33,008	Mrs. P. A. Grey	3832	May 28, 1877	82 50
42,837	G. W. Nicholas	3834	May 28, 1877	15 75
42,119	W. H. Oliver and two others	3838	May 28, 1877	66 62
38,148	Mrs. Rebecca Smith	3839	May 28, 1877	10 00
32,432	George Thomas, (in part)	3842	May 28, 1877	56 00
42,934	James Whitworth, (in part)	3843	May 28, 1877	79 00

Schedule of claims, &c.—Regular supplies, Quartermasters' department, 1871 and prior years—Continued.

No. of claim.	Name of claimant.	No. of sett.	Date.	Amount.
36,193	Peterson Johnson	3855	May 29, 1877	$41 25
28,080	Martha Kennedy	3857	May 29, 1877	34 50
24,484	Wm. Hunt, administrator of Nancy Trimble, deceased	3863	May 29, 1877	32 00
33,054	B. W. Humphrey	3864	May 29, 1877	12 25
37,131	Mrs. G. Mason	3865	May 29, 1877	25 00
40,756	John G. Johnson	3870	May 31, 1877	6 00
42,838	Mrs. Sarah Hammon	3873	May 31, 1877	22 50
35,200	Mrs. Hurt	3874	May 31, 1877	12 00
33,419	John Hyer	3876	May 31, 1877	3 75
32,612	David Backman	3899	June 4, 1877	13 50
29,431	Sackford Brewer	3903	June 4, 1877	13 00
26,445	Heirs of Jacob Eley, (Asa Derrick, guardian)	3908	June 4, 1877	40 00
32,614	Abram Dean	3909	June 4, 1877	21 00
27,648	Frank Dickens	3910	June 4, 1877	10 00
43,953	Byrd Douglas	3913	June 4, 1877	568 00
38,957	L. M. Ellis	3915	June 4, 1877	25 00
42,183	John English	3916	June 4, 1877	22 40
35,550	Isaac Garretson	3917	June 4, 1877	30 00
44,078	I. H. Grainger	3918	June 4, 1877	5 00
44,123	Elizabeth W. Gleaves	3919	June 4, 1877	97 50
35,550	Cheney Finger Wid, of Stephen	3920	June 4, 1877	7 60
40,661	Adam H. Flesher and one other	3922	June 4, 1877	41 95
32,736	James Rogers	3923	June 4, 1877	4 00
40,573	Perry Gant	3931	June 5, 1877	10 00
44,013	W. A. Johnson	3933	June 5, 1877	7 00
35,953	Mrs. Mary Murray	3939	June 5, 1877	49 14
33,231	John P. McKay	3943	June 5, 1877	2 25
40,856	S. B. Prichard	3944	June 5, 1877	30 00
24,881	Levi Pifer	3946	June 5, 1877	36 00
32,481	Preston T. Potter	3947	June 5, 1877	6 00
44,189	William Son	3949	June 5, 1877	4 50
43,428	K. D. Nicoll	3957	June 5, 1877	98 75
27,816	John E. Winn, (in part)	3960	June 5, 1877	19 50
32,597	R. C. Wright	3962	June 5, 1877	19 55
42,111	C. Zimmerman	3963	June 5, 1877	42 00
44,000	Adam Barley	4009	June 7, 1877	13 50
39,525	N. Carper	4012	June 7, 1877	21 25
44,184	J. W. Neely, deceased, (R. P. Moss, executor)	4016	June 7, 1877	50 00
42,022	Smith Chadwick & Co	4019	June 7, 1877	250 00
40,570	J. M. Carmel	4028	June 9, 1877	10 00
51,512	Mary G. Dunning	4030	June 9, 1877	20 00
31,509	Wiley Douglass	4031	June 9, 1877	4 20
31,508 } 31,513 }	George Elliott	4033	June 9, 1877	12 60
44,121	Robert Harper, deceased, (Jas. J. Turner, executor)	4040	June 9, 1877	65 00
44,225	George Venable	4041	June 9, 1877	21 60
40,556	Jacob Williamson	4042	June 9, 1877	50 40
44,041	John Warren	4043	June 9, 1877	25 00
31,510	Sarah White	4046	June 9, 1877	15 00
44,054	Josiah Backhouse	4066	June 14, 1877	15 75
44,056	Fielding Berry	4067	June 14, 1877	7 70
44,057	George Brown	4068	June 14, 1877	30 00
39,237	Leonard Davis	4069	June 14, 1877	98 20
44,058	Peter Duffy	4070	June 14, 1877	34 30
44,059	Squire Fitzwaters	4072	June 14, 1877	40 00
44,060	Wm. Groves	4073	June 14, 1877	17 25

Schedule of claims, &c.—Regular supplies, Quartermasters' department, 1871 and prior years—Continued.

No. of claim.	Name of claimant.	No. of sett.	Date.	Amount.
44,061	Jeff Grosse	4074	June 14, 1877	$35 50
44,063	Jefferson Jackson	4075	June 14, 1877	12 90
44,066	Benj. S. Kidmore	4076	June 14, 1877	20 00
44,064	J. B. Muncey	4077	June 14, 1877	18 00
44,065	H. W. Powell	4078	June 14, 1877	3 00
44,067	Eliza Tyree	4080	June 14, 1877	19 06
40,577	Henry Loudon	4096	June 19, 1877	6 00
23,462	H. B. Hardy	4125	June 22, 1877	25 00
	Levi Putnam	4126	June 22, 1877	1 70
	John Ramsour	4128	June 22, 1877	124 00
	James Wickwire	4134	June 22, 1877	108 00
40,330	Parkes E. Ball	4336	Aug. 8, 1877	15 00
24,987	John H. Dennis	4344	Aug. 8, 1777	6 00
26,821	Neil Breeding	4340	Aug. 9, 1877	36 00
27,533	John Alexander	4335	Aug. 9, 1877	4 00
30,257	John B. Edmoudson	4345	Aug. 8, 1877	90 00
27,156	John Turley	4376	Aug. 9, 1877	27 50
38,320	Columbus L. Shelton	4370	Aug. 9, 1877	3 60
39,520	John Smith	4372	Aug. 9, 1877	35 00
42,921	A. F. Taylor	4378	Aug. 9, 1877	78 00
38,506	John Ward	4379	Aug. 9, 1877	7 46
42,061	Wm. Thornburg	4377	Aug. 9, 1877	47 50
44,188	Thos. L. Steger	4375	Aug. 9, 1877	23 10
44,269	John McGinnis	4361	Aug. 9, 1877	23 50
30,558	Miss Mary J. Leavell	4359	Aug. 9, 1877	13 31
42,098	Mabel Poston	4365	Aug. 9, 1877	8 50
33,869	R. K. Young, (part under Ar. Trans., 1871 and prior)	4387	Aug. 10, 1877	30 00
25,912	Maryland Gas Co	4391	Aug. 10, 1877	34 50
12,817	William Lincoln, ($2 under Ar. Trans., 1871 and prior)	4417	Aug. 15, 1877	28 00
38,338	J. E. Manlove	4462	Aug. 22, 1877	60 00
40,411	B. Marable	4460	Aug. 22, 1877	99 75
40,276	Alfred Hutchinson	4458	Aug. 22, 1877	37 50
29,466	Henry T. Webb	4466	Aug. 22, 1877	100 00
31,406	Thomas C. Ryall	4464	Aug. 22, 1877	63 00
24,965	Wakefield & Son, (incidental expenses, $23 14; barracks and quarters, $15 51; total, $46)	4498	Sept. 1, 1877	7 35
42,068	Thornton S. Pattie	4537	Sept. 8, 1877	18 00
42,053	Joseph Paffenberger	4536	Sept. 8, 1877	29 50
29,919	John Vaden	4539	Sept. 8, 1877	84 00
44,936	R. S. Leigh	4561	Sept. 13, 1877	70 00
35,704	Thos. West	4580	Sept. 22, 1877	90 00
38,953	Amos Gater	4582	Sept. 22, 1877	16 00
44,666	Jno. Price	4575	Sept. 22, 1877	9 00
44,636	Wm. J. Miller	4635	Oct. 9, 1877	63 00
38,948	N. L. Clardy	4572	Sept. 22, 1877	6 00
38,949	Casson Snell	4583	Sept. 22, 1877	13 00
44,622	Jacob Shaver	4579	Sept. 22, 1877	20 00
44,455	Jno. Dougherty	4574	Sept. 22, 1877	20 00
44,692	Daniel Jones	4581	Sept. 22, 1877	22 00
38,363	Mathew Roberts	4577	Sept. 22, 1877	44 00
44,933	Wm. M. Locke	4633	Sept. 22, 1877	2 35
44,956	Peter C. Depaum	4643	Oct. 9, 1877	31 00
44,658	Lucinda McClenden	4634	Oct. 9, 1877	5 00
44,660 44,662	Philip Howell	4631		282 50
44,661	Wm. J. Orrick	4636	Oct. 9, 1877	47 00
26,900	J. A. Donnelly & Co	4645	Oct. 9, 1877	599 10

Schedule of claims, &c.—Regular supplies, Quartermasters' department, 1871 and prior years—Continued.

No. of claim.	Claimant.	No. of sett.	Date.	Amount.
42,041	Cynthia Foster	4628	Oct. 9, 1877	$25 00
42,047	Walker Reynolds	4640	Oct. 9, 1877	50 00
44,682	John Cooper	4626	Oct. 9, 1877	23 75
44,735	Gillmore Randolph	4639	Oct. 9, 1877	85 00
44,659	Zeph. C. Duncan	4642	Oct. 9, 1877	27 90
	Austin Curtin, Lieut., (settlement by Q. M. Div., Third Auditor's Office)	4653	Oct. 12, 1877	12 15
30,361	William Bomar	4659	Oct. 9, 1877	10 00
30,360	Matilda Brown	4662	Oct. 9, 1877	5 00
30,367	J. E. Couch	4664	Oct. 9, 1877	50 00
30,369	M. Dixon	4665	Oct. 9, 1877	20 50
30,370	J. N. Dunaway	4666	Oct. 9, 1877	12 50
44,474	William Williams, jr., exec'r of William Williams	4669	Oct. 9, 1877	141 00
30,396	Wm. Word	4706	Oct. 15, 1877	4 50
30,395	W. H. Wisener	4704	Oct. 15, 1877	12 00
30,388	Isaac Troxton	4702	Oct. 15, 1877	60 00
30,386	J. A. Denison	4701	Oct. 15, 1877	15 50
30,385	Dr. Scott	4698	Oct. 15, 1877	25 00
30,379	J. L. Rosborough	4696	Oct. 15, 1877	12 50
30,377	P. Moppin	4691	Oct. 15, 1867	30 00
30,376	R. H. Lewis & Co	4688	Oct. 15, 1877	5 65
30,375	A. S. Lawrence	4687	Oct. 15, 1877	22 50
30,374	Jacob Kyser	4686	Oct. 15, 1877	31 00
30,373	W. A. Houston	4684	Oct. 15, 1867	25 00
45,073	Absalom Miller	4813	Nov. 10, 1877	162 60
44,937	William S. Weddle	4818	Nov. 10, 1877	94 50
44,475	Geo. W. Charlton, (E. and L. Charlton, administrators)	4805	Nov. 10, 1877	30 00
42,046	Thomas H. Reynolds	4815	Nov. 10, 1877	195 00
28,018	R. W. Boggs	4829	Nov. 13, 1877	24 00
45,159	Benj. F. Chastain, (see below)	4836	Nov. 13, 1877	18 00
45,160	James Garrett	4846	Nov. 13, 1877	22 00
44,107	John Austin	4828	Nov. 13, 1877	6 00
45,158	Benj. F. Chastain, (see above)	4837	Nov. 13, 1877	16 00
45,164	Elisha Sullivan	4859	Nov. 13, 1877	60 00
45,162	J. Henry King	4852	Nov. 13, 1877	95 60
45,161	Jas. Harris	4849	Nov. 13, 1877	8 00
45,138	Anson Lane	4850	Nov. 13, 1877	40 00
44,040	John Alstadt	4920	Nov. 23, 1877	42 00
42,250	J. J. Brown	4930	Nov. 26, 1877	3,600 00
24,478	James Cather	4952	Nov. 27, 1877	88 07
24,325	James Hott	4968	Nov. 27, 1877	104 00
31,956	Polly Ann Kelly	4974	Nov. 27, 1877	15 00
30,532	Chas. O'Hara	4979	Nov. 27, 1877	24 00
26,658	James Brumfield	4926	Nov. 26, 1877	57 02
26,588	G. C. C. Kerr	4975	Nov. 27, 1877	40 78
22,628	Mrs. Nancy Call	4932	Nov. 27, 1877	5 25
22,628	Thomas Murray	4938	Nov. 26, 1877	3 20
	R. Murry	4939	Nov. 26, 1877	8 50
	Geo. Miller	4940	Nov. 26, 1877	9 00
	W. H. Baker	4927	Nov. 26, 1877	5 00
	James H. Call	4934	Nov. 26, 1877	2 50
	Geo. A. Brown	4928	Nov. 26, 1877	6 50
	S. Cooley	4933	Nov. 26, 1877	7 00
	John Grimes	4936	Nov. 26, 1877	6 40
28,492	Aaron Kernoll	4976	Nov. 27, 1877	33 75
39,257	Alex. Crowder	4957	Nov. 27, 1877	25 00
35,999	Wm. M. Abell	4925	Nov. 26, 1877	30 50
39,445	Joseph Black	4931	Nov. 26, 1877	12 50

Schedule of claims, &c.—Regular supplies, Quartermasters' department, 1871 and prior years—Continued.

No. of claim.	Name of claimant.	No. of sett.	Date.	Amount.
44,618	Mrs. Bridget Callahan	4951	Nov. 27, 1877	$112 50
35,906	Benj. Duvall	4960	Nov. 27, 1877	33 75
35,878	J. T. Day	4959	Nov. 27, 1877	48 00
40,648	Thos. A. Dixon	4958	Nov. 27, 1877	6 00
37,985	Peter Fuqua, (W. D. Baker, executor)	4961	Nov. 27, 1877	83 90
44,763	Geo. Fisher	4963	Nov. 27, 1877	192 50
35,950	G. R. Hays	4967	Nov. 27, 1877	60 00
27,652	Mrs. Martha Mathews	4983	Nov. 28, 1877	100 00
33,797	Samuel McPherson	4985	Nov. 28, 1877	114 50
42,467	Isaac Masoner	4988	Nov. 28, 1877	21 60
40,484	Jacob Mann	4987	Nov. 28, 1877	390 40
35,306	J. M. Pennington	4991	Nov. 28, 1877	27 50
28,990	John T. Rasnick	4992	Nov. 28, 1877	21 00
27,746	W. G. Robinson	4995	Nov. 28, 1877	15 00
29,716	Anthony Thornton	5000	Nov. 28, 1877	81 03
25,447	E. G. W. Sellers	4996	Nov. 28, 1877	30 00
43,970	W. H. Wood	5005	Nov. 28, 1877	24 00
42,444	L. W. Williams	5006	Nov. 28, 1877	39 00
26,594	James Tallant	5002	Nov. 28, 1877	44 50
29,303	Samuel Wade and Benjamin Johnson—$24; $7 20	5007	Nov. 28, 1877	31 20
26,609	William Woodson—subsistence, $152 83; C. and A. horses, $310; total, $580 33	5008	Nov. 28, 1877	118 00
40,887	Jentile Braley	5114	Dec. 15, 1877	15 00
45,046	Elizabeth Bradley	5116	Dec. 15, 1877	11 25
39,434	Samuel Crawford	5122	Dec. 17, 1877	10 50
43,429	G. W. Elliott	5125	Dec. 17, 1877	8 60
40,460	J. M. Elkins	5129	Dec. 17, 1877	12 00
45,085	J. W. Hawes	5132	Dec. 17, 1877	507 00
27,636	James Eatherly	5126	Dec. 17, 1877	50 00
12,680	Seaborn Jones, $75; Charles H. Collin, $26 25; William Walker, $75	5145	Dec. 18, 1877	176 25
32,857	G. R. Hepley	5143	Dec. 18, 1877	25 00
25,669	William G. Jenkins	5146	Dec. 18, 1877	24 00
38,074	Samuel J. Alsup	5197	Dec. 21, 1877	152 50
45,056	Henderson Bohannan	5199	Dec. 21, 1877	18 00
35,705	A. Cobb, deceased, (Thomas P. Cobb, administrator)	5203	Dec. 21, 1877	125 00
45,268	Boothe Dalton	5204	Dec. 21, 1877	46 00
44,953	William Harvick	5208	Dec. 21, 1877	6 00
28,409	John Hubbard	5211	Dec. 21, 1877	16 00
27,857	S. B. Hawkins	5209	Dec. 31, 1877	42 00
45,050	Madison Halfacre	5212	Dec. 21, 1877	39 00
45,603	Delila Kelley	5213	Dec. 21, 1877	22 00
45,602	Hiram Long	5214	Dec. 21, 1877	15 00
41,925	A. J. McAlister	5215	Dec. 21, 1877	13 50
26,858	George W. Matlock	5216	Dec. 21, 1877	2 25
45,270	Maunen & Watson	5218	Dec. 21, 1877	43 87
20,840	Thomas Long	5154	Dec. 20, 1877	20 00
45,235	L. H. Machen	5457	Dec. 20, 1877	232 50
25,681	George W. Watkins	5158	Dec. 20, 1877	40 50
45,283	George W. Moore	5163	Dec. 20, 1877	50 73
35,755	H. E. Miller	5165	Dec. 20, 1877	78 75
45,324	F. McAtie	5167	Dec. 20, 1887	91 00
35,933	Alexander O'Bryhen	5169	Dec. 20, 1877	18 00
35,531	Townsly Pyott	5170	Dec. 20, 1877	15 00
40,680	James Sewell	5176	Dec. 20, 1877	30 00
45,086	John Thompson	5180	Dec. 20, 1877	36 60
31,420	Daniel S. Tucker	5181	Dec. 20, 1877	107 00
45,020	Samuel Zimmerman	5187	Dec. 20, 1877	25 40

Schedule of claims, &c.—Regular supplies, Quartermasters' department, 1871 and prior years—Continued.

No. of claim.	Name of claimant.	No. of sett.	Date.	Amount.
44,635	Samuel Benedict, deceased, (J. S. Cunningham, administrator,) $231 92 under Barracks and Quarters	5192	Dec. 20, 1877	$17 00
45,298	D. G. Perdue	5223	Dec. 23, 1877	6 30
44,680	George Parker	5524	*Dec. 23, 1877	25 00
40,386	Charles A. Redd	5226	Dec. 23, 1877	86 50
28,406	Jesse Stribling	5228	Dec. 23, 1877	10 00
45,605	John Thompson	5230	Dec. 23, 1877	11 10
44,827	J. W. Wyatt	5232	Dec. 23, 1877	12 50
45,245	Thornton B. Cooper	5235	Dec. 23, 1877	22 50
45,267	James M. Lee	5236	Dec. 23, 1877	20 00
34,970	William Mosely	5237	Dec. 23, 1877	29 32
45,614	R. E. Miles	5238	Dec. 23, 1877	750 00
45,269	B. H. Sterrett	5241	Dec. 23, 1877	30 00
38,078	A. B. C. Dickerson	5258	Dec. 23, 1877	144 00
	Total			23,359 84

*Or December 22, 1877.

REGULAR SUPPLIES, QUARTERMASTERS' DEPARTMENT, 1872.—(For reappropriation.)

42,917	Detroit Daily Post Company	2492	Mar. 16, 1877	$29 70
44,020	Captain W. H. Wessels, Third Cavalry	3553	April 18, 1877	281 52
44,679	J. F. Wade, ($268 80, under Barracks and Quarters, 1872)	4465		54 88
	Total			366 10

REGULAR SUPPLIES, QUARTERMASTERS' DEPARTMENT, 1873.—(For reappropriation.)

32,787	United States Ordnance Department	3954	June 5, 1877	$525 09
40,826	F. C. Myrick	3778	May 12, 1877	157 50
	Total			682 59

REGULAR SUPPLIES, QUARTERMASTERS' DEPARTMENT, 1874.—(For reappropriation.)

43,661	Magdalena Calderon, (part paid)	3516	April 17, 1877	$163 20
40,338	Joseph Miller	3744	May 8, 1877	280 93
42,032	S. B. Spotts	3953	June 5, 1877	50 82
45,530	William Memmott	5160	Dec. 19, 1877	10 00
	Total			504 95

REGULAR SUPPLIES, QUARTERMASTERS' DEPARTMENT, 1875.—(For reappropriation.)

44,617	Myers & Leonard	4500	Sept. 1, 1877	$166 91
45,384	J. C. Hopkins	4969	Nov. 27, 1877	37 68
45,281	William Curry	4954	Nov. 27, 1877	12 55
45,494	Quirini Baca	5115	Dec. 15, 1877	30 75
	Total			247 89

Schedule of claims, &c.—Continued.

INCIDENTAL EXPENSES, QUARTERMASTERS' DEPARTMENT, 1871 AND PRIOR YEARS.—(For reappropriation.)

No. of claim.	Name of claimant.	No. of sett.	Date.	Amount.
40,308	S. J. Sargent	1935	Dec. 18, 1876	$23 75
41,556	Wm. Ashmead	2050	Jan. 13, 1877	23 00
40,742	Cincinnati Gazette Co	2068	Jan. 15, 1877	32 00
39,560	Edward Dundon	2102	Jan. 17, 1877	20 00
42,641	Fletcher Stroud	2116	Jan. 19, 1877	46 00
42,153	Isaac Ramsey	2117	Jan. 29, 1877	20 00
40,446	William Hummel	2140	Jan. 29, 1877	25 75
40,565	David Anderson	2149	Jan. 20, 1877	23 00
40,634	Oscar Martin	2153	Jan. 22, 1877	40 00
38,594	Welcome James	2262	Feb. 10, 1877	49 00
42,071	Michael Colligan	2264	Feb. 10, 1877	45 75
42,027	James E. Guerins	2269	Feb. 12, 1877	51 00
25,247	David Palmer, guardian, &c	2282	Feb. 13, 1877	80 00
36,396	Joseph McPherson & Co	2307	Feb. 14, 1877	44 20
29,185	Isaac W. Moisett, administrator of James Perry, deceased	2342	Feb. 21, 1877	71 67
42,781	Chrest Bolons	2345	Feb. 22, 1877	31 50
40,779	Levi Simpson and one other	2388	Feb. 27, 1877	133 32
42,026	John James	2389	Feb. 27, 1877	25 66
41,198	Estate of Wm. Wright, (G. B. Wright, administrator)	2391	Feb. 27, 1877	500 00
42,818	Morty Downing, father of D. O. C. Downing	2421	Mar. 8, 1877	446 60
38,900	John W. Parks	2427	Mar. 8, 1877	23 75
40,717	Silas H. Hopkins	2434	Mar. 9, 1877	78 00
	James A. Sawyer, Lt. Sioux City Cav	2481	Mar. 15, 1877	50 70
40,560	Charles Johnson	2494	Mar. 16, 1877	2,850 00
39,694	John W. McCoy	2502	Mar. 16, 1877	114 40
42,915	Michael and Jerry Shea	2504	Mar. 16, 1877	25 00
	H. L. Robinson, Capt. and A. Q. M	2576	Mar. 20, 1877	628 08
	Charles Sidney Smith, Lt. 4th R. I. Vols	3432	Apr. 7, 1877	116 90
40,544	James H. Stark	3455	Apr. 9, 1877	105 00
43,657	J. E. Braden, (in part)	3515	Apr. 17, 1877	38 75
42,849	Chas. Theo. Potts, deceased	3538	Apr. 18, 1877	54 80
31,997	William Pitts	3562	Apr. 20, 1877	75
42,899	T. J. Moore and seven others, (*i. e.*, Jno. Henderson)	3620	Apr. 23, 1877	5 00
40,058	John Gray and three others	3624	Apr. 25, 1877	42 40
40,756	James McGraw	3666	May 2, 1877	6 00
42,836	Milton Newport	3668	May 2, 1877	53 33
38,559	Thos. J. Reidy	3670	May 2, 1877	70 00
40,063	Thos. F. Arnold	3683	May 3, 1877	42 00
42,120	John W. Horn	3703	May 4, 1877	1,380 00
44,003	Edward Simpson and three others	3779	May 12, 1877	140 00
44,167	J. A. McClure	3833	May 28, 1857	45 00
43,662	Charleston Harvey and two others	3859	May 29, 1877	66 02
28,995	Abel F. Kenney and one other	3871	May 31, 1877	62 25
44,192	Charles Henry Hastings	3875	May 31, 1877	84 34
40,730	A. Gallatin Lovell and twenty-nine others	3890	June 1, 1877	566 00
42,841	Sarah Ely, widow of Geo. W. Ely	3891	June 1, 1877	66 80
44,162	Wm. Barnemann	3897	June 4, 1877	14 00
36,243	Elias Cheatman	3905	June 4, 1877	18 00
40,598	Thomas Davis	3912	June 4, 1877	399 41
38,718	John Ryon	3924	June 4, 1877	16 20
36,212	James Livingston	3934	June 5, 1877	18 00
42,792	Washington Savage	3952	June 5, 1877	30 31
40,559	Duncan Ward	3961	June 5, 1877	729 00

Schedule of claims, &c.—Incidental expenses, Quartermasters' department, 1871 and prior years—Continued.

No. of claim.	Name of claimant.	No. of sett.	Date.	Amount.
36,508	J. R. Alford	4008	June 7, 1877	$98 99
40,607	W. McNames	4015	June 7, 1877	12 00
40,412	Merrick Sykes	4020	June 7, 1877	11 20
44,168	Emma Jones	4034	June 9, 1877	150 00
33,242	George Watson	4045	June 9, 1877	23 75
44,278	J. M. Bates	4082	June 15, 1877	99 00
40,519	Fancher, deceased, heirs of Lewis H	4346	Aug. 8, 1877	176 66
40,422	H. Petschow	4366	Aug. 9, 1877	154 00
44,299	Peter Shell	4373	Aug. 9, 1877	11 20
44,220	Robert Hays, $67 50; Thomas Lewis, $52; Lewis Jacobs, $18 67	4356	Aug. 9, 1877	138 17
39,171	Miles Marshall	4360	Aug. 9, 1877	22 50
44,315	Richard Robinson	4367	Aug. 9, 1877	14 00
29,412	Simon Abeles, (Second Comptroller's settlement.) Total allowed, $529; paid by requisition of May 17, 1877, $524 87; leaving balance	2237	Feb. 5, 1877	4 13
24,965	Wakefield & Son, Q. M. D., $7 35; Barracks and Quarters, $15 51; total allowed, $46	4498	Sept. 1, 1877	23 14
44,321	Joshua B. Meadwell	4596	Sept. 28, 1877	48 00
45,133	Lieut. Wm. V. Wolfe	4652	Oct. 12, 1877	72 20
44,742	Geo. B. Booth	4660	Oct. 12, 1877	266 80
44,916	Joseph Woolridge	4705	Oct. 15, 1877	11 66
	August Thiemann, late major; (settlement made by Q. M. Div.)	3171	April 3, 1877	10 00
44,917	Richard Coleman	4835	Nov. 13, 1877	8 00
44,730	R. P. Lightburn	4851	Nov. 13, 1877	650 00
35,077	Henry Barr	4830	Nov. 13, 1877	48 80
40,281	Dudley G. Leavey	4858	Nov. 13, 1877	745 50
44,672	Robt. Cochrane, deceased, (G. M. Darnall, administrator)	4953	Nov. 27, 1877	388 50
38,421	John Casey	4955	Nov. 27, 1877	48 80
45,265	Elijah Roberts	4993	Nov. 27, 1877	17 00
45,587	San Antonio Express	5134	Dec. 17, 1877	42 00
45,395	Geo. Hudson	5140	Dec. 18, 1877	17 54
45,588	"Houston Union"	5141	Dec. 18, 1877	18 00
	James M. Ropes, lieutenant 8th cavalry; (settlement by Q. M. Div.)	5046	Dec. 6, 1877	4 00
44,690	J. S. Clark, Chas. Boley, Samuel Spray, John Wiley, and Archibald McDonald, $25 each, (Daniel M. Adams, holder and owner)	5207	Dec. 21, 1877	125 00
30,116	Bernard Fort	5205	Dec. 21, 1877	5 00
44,535	Stephen James, $156; Thomas Ellis, $117	4512	Sept. 5, 1877	273 00
	Total			13,410 93

Schedule of claims, &c.—Continued.

INCIDENTAL EXPENSES, QUARTERMASTERS' DEPARTMENT, 1873.—(For reappropriation.)

No. of claim.	Name of claimant.	No. of sett.	Date.	Amount.
40,687	Western Union Telegraph Company, (in part,) $79 94; Kansas Pacific Railroad Company, $289 24	2235	Feb. 5, 1877	$369 18
31,783	E. L. Violland and seven others	2283	Feb. 13, 1877	506 30
31,356	Capt. Theo. J. Eckerson	2326	Feb. 17, 1877	19 95
39,947	Union Pacific Railroad Co., $1,434 04; Central Pacific Railroad Co., $36 84	2172	Jan. 24, 1877	1,470 88
43,989	Alex. Dever, (part paid)	3501	Apr. 14, 1877	7 00
44,190	John Ernst	3914	June 4, 1877	12 20
	Total			2,385 51

INCIDENTAL EXPENSES, QUARTERMASTERS' DEPARTMENT, 1875.—(For reappropriation.)

44,176	Union Pacific Railroad Company	4256	July 19, 1877	$467 83
44,433	Union Pacific Railroad Company	4608	Oct. 3 1877	1,212 45
44,386	Western Union Telegraph Company, $138 17; Kansas Pacific Railroad Company, (one-half payable to Western Union Telegraph Company,) $321 68	4782	Nov. 3, 1877	459 85
44,344	Union Pacific Railroad Company	4783	Nov. 6, 1877	551 62
	Total			2,691 75

CLOTHING, CAMP AND GARRISON EQUIPAGE, 1871 AND PRIOR YEARS.—(Reappropriation.)

42,466	Brogius & Riley	4942	Nov. 26, 1877	$58 05

CLOTHING, CAMP AND GARRISON EQUIPAGE, 1873.—(Reappropriation.)

45,291	Capt. E. C. Bainbridge, 5th Artillery	4882	Nov. 15, 1877	$239 82

CLOTHING, CAMP AND GARRISON EQUIPAGE, 1874.—(Reappropriation.)

	Lieut. Jas. E. Macklin, (settlement by Quartermaster's Division)	1997	Sept. 26, 1874	$8 57
	Lieut. Gustavus M. Bascom, (settlement by Quartermaster's Division)	3895	June 4, 1877	2 78
	Total			11 35

Schedule of claims, &c.—Continued.

TRANSPORTING OFFICERS' BAGGAGE, 1871 AND PRIOR YEARS.—(Reappropriation.)

No. of claim.	Name of claimant.	No. of sett.	Date.	Amount.
42,843	H. S. Kilborne	3436	Apr. 7, 1877	$15 40
43,637	J. E. Braden	3515	Apr. 17, 1877	1 80
43,964	August Thieman, (in part)	3671	May 2, 1877	34 20
44,335	Frank B. Marshall	4137	June 23, 1877	247 10
44,021	Wm. Shields, by his widow, Sarah A	4374	Aug. 9, 1877	80 70
36,208	Thos. Foster, late Captain	4578	Sept. 22, 1877	25 14
44,270	Edw. S. Johnson	4972	Nov. 27, 1877	71 46
45,172	S. S. Culbertson	5119	Dec. 17, 1877	103 07
45,155	J. M. Lee	5152	Dec. 19, 1877	82 90
45,127	Wm. J. Reed	5173	Dec. 19, 1877	178 00
44,012	H. L. Taliaferro	5231	Dec. 22, 1877	83 40
	Total			923 17

RELIEF OF PERSONS SUFFERING FROM RAVAGES OF GRASSHOPPERS.—(Reappropriation.)

	Capt. E. B. Grimes, A. Q. M., (settlement by Quartermaster's Division)	2229	Sept. 10, 1877	$663 99

SUBSISTENCE OF THE ARMY, 1871 AND PRIOR YEARS.—(Reappropriation.)

41,932	Thomas H. Stone, administrator, &c	2286	Feb. 14, 1877	$36 00
42,011	O. H. P. Bennett	2303	Feb. 15, 1877	30 00
20,548	Peter C. Talley	2313	Feb. 16, 1877	15 00
42,839	Sarah A. Carter	2369	Feb. 23, 1877	125 00
38,919	M. W. Hinkle	2387	Feb. 26, 1877	45 00
42,366	W. R. Humbard	2407	Mar. 7, 1877	36 00
33,816	Moses Cunningham	2489	Mar. 15, 1877	170 00
42,097	John McKelvey, (A. W. Rect, H. and O.)	3435	April 9, 1877	40 00
35,309 35,310	Boston Clapp $14 25 Jane Vienable 17 25	3621	April 25, 1877	31 50
42,888	John Ammahaie	3710	May 5, 1877	156 58
44,113	A. Henderson	3771	May 11, 1877	134 25
41,202	George Johnson, deceased	3772	May 11, 1877	180 00
40,868	P. B. Weir	3786	May 12, 1877	140 00
44,158	Lafayette Turner	3841	May 28, 1877	37 75
20,800	A. C. Barta, deceased, (Thomas Coghlan, administrator)	3904	June 4, 1877	49 17
43,589	Samuel Cottrell	3906	June 4, 1877	43 84
34,957	John K. Garner	3932	June 5, 1877	10 50
35,550	Mrs. Elinda Morrow	3935	June 5, 1877	14 40
8,800	William Thompson, deceased, (Meek and Keever, administrators)	3940	June 5, 1877	47 90
44,125	Samuel McElrath	3941	June 5, 1877	6 60
44,159	John L. Williams	3959	June 5, 1877	69 75
27,816	John E. Winn, (in part)	3960		9 45
27,405	E. P. Burns	4062	June 13, 1877	32 00
44,053	Julia A. Evans	4124	June 22, 1877	95 10
23,462	W. Sanford	4127	June 22, 1877	91 45
42,185	Anton Huber	4144	June 25, 1877	6 40
44,384	Elmore C. Argadine	4334	Aug. 8, 1877	55 08
38,451	Ursin Bobin	4338	Aug. 8, 1877	200 00
44,459	Frederick Stein	4369	Aug. 8, 1877	7 50

Schedule of claims, &c.—Subsistence of the Army, 1871 *and prior years*—Continued.

No. of claim.	Name of claimant.	No. of sett.	Date.	Amount.
44,572	Susan Hinkle	4357	Aug. 8, 1877	$120 00
	Junius M. Palmer, late Capt. and C. S., (settlement made by Subsistence Division)	2162	Aug. 20, 1877	108 25
41,508	Samuel S. Eason	2225	Sept. 8, 1877	64 45
31,672	Elizabeth Elms, (widow of Ichabod Herring)	2272	Sept. 28, 1877	78 75
45,088	Henry Hutchinson	2278	Oct. 2, 1877	14 75
44,467	John White	2311	Oct. 12, 1877	30 00
26,001	Jacob Talbot	2313	Oct. 15, 1877	34 08
44,922	S. M. Scott	2314	Oct. 15, 1877	92 00
44,948	Thomas Moran	2315	Oct. 15, 1877	175 00
44,670	Sidney A. Moulthrop	2368	Nov. 10, 1877	89 90
45,047	Richard Butts	2401	Nov. 26, 1877	81 55
40,375	N. L. Fonts, (Samuel Parks, holder and owner)	2415	Nov. 27, 1877	5 60
45,293	Denis Neligan	2428	Nov. 28, 1877	56 00
26,609	Wm. Woodson, ($118 under Q. M. D.; $310 under C. and A. H.; total, $380 33)	5008	Nov. 28, 1877	152 83
20,346	John Burke, (Cath. N. Burke, adm'x)	2567	Dec. 15, 1877	33 00
39,700	William R. Hyde	2597	Dec. 18, 1877	210 00
45,336	James Jackson, deceased, (Hannah Jackson, his widow)	2599	Dec. 18, 1877	6 25
44,530	John W. Morgan	2615	Dec. 19, 1877	26 33
40,954	Hyram Long	2625	Dec. 21, 1877	27 50
33,595	A. C. Bryan	2628	Dec. 21, 1877	72 05
45,646	Henry Tyler	2639	Dec. 22, 1877	25 00
45,243	Jacob Long	2646	Dec. 26, 1877	8 80
19,849	G. D. Jenks	2647	Dec. 26, 1877	675 00
25,648	Julia A. Reed	2644	Dec. 26, 1877	1,494 60
24,447	Andrew D. Campbell	2192	Sept. 1, 1877	220 80
	Total	......	....	5,818 71

SUBSISTENCE OF THE ARMY, 1873.—(Reappropriation.)

44,667 } 44,668 }	Detroit "Daily Post," ($1 90 under 1874)	2270	Sept. 28, 1877	$1 90

SUBSISTENCE OF THE ARMY, 1874.—(Reappropriation.)

44,667 } 44,668 }	Detroit "Daily Post," ($1 90 under 1873	2270	Sept. 28, 1877	$1 90

SUBSISTENCE OF THE ARMY, 1875.—(Reappropriation.)

45,397	Joseph Siegfried	2429	Nov. 28, 1877	$8 25

Schedule of claims, &c.—Continued.

PAY, TRANSPORTATION SERVICES, AND SUPPLIES, OF OREGON AND WASHINGTON TERRITORY VOLUNTEERS IN 1855, '56.—(Reappropriation.)

No. of claim.	Name of claimant.	No. of sett.	Date.	Amount.
4,623	W. H. Gates, adm'r of E. D. Byrne, dec'd.	1990	Jan. 8, 1877	$570 40
4,624	A. M. Gibbons, administrator of Daniel Wilson, deceased	1998	Jan. 8, 1877	73 46
4,625	Thomas Monteith and others	2065	Jan. 15, 1877	241 92
4,626	Jasmes Elkins and George A. Edes	2164	Jan. 22, 1877	379 00
4,627	William Dorn	2163	Jan. 22, 1877	38 83
4,628	John H. Good	2166	Jan. 22, 1877	15 20
4,630	William Johnson	2177	Jan. 25, 1877	10 80
4,631	Andrew J. Miller	2178	Jan. 25, 1887	7 66
4,629	Samuel E. May	2246	Feb. 9, 1877	664 00
4,633	Thomas Fagan	2247	Feb. 9, 1877	72 00
4,618	Peter Miller, and Miller & Haney	2251	Feb. 9, 1877	219 00
4,622	Keith & Johnson	2252	Feb. 9, 1877	231 74
4,632	Isaac N. Bently	2573	Mar. 20, 1877	337 50
4,635	Samuel E. May	2660	Mar. 23, 1877	1,085 00
4,634	Jefferson Bump, Samuel Ritchie, and Carlton A. Geer	3135	April 2, 1877	844 00
4,636	John Goldsby	3418	April 6, 1877	38 83
4,637	George A. Edes	3568	April 20, 1877	632 22
4,638	David Feese	3690	May 3, 1877	17 53
4,642	Jacob McDaniel	3780	May 12, 1877	89 32
4,643	Jason J. Braman	3781	May 12, 1877	100 14
4,644	William Daly	3782	May 12, 1877	8 40
4,645	John Springer	3800	May 18, 1877	50 40
4,646	James F. Cleaver	3966	June 6, 1877	94 22
4,649	Jno. Williams, dec'd, (Nelson Hoyt, adm'r)	3971	June 6, 1877	292 67
4,641	George A. Coffin and Levi Gillam	4083	June 18, 1877	100 44
4,650	William B. Eddins	4084	June 18, 1877	19 67
4,652	William Horsley	4085	June 18, 1877	12 78
4,653	Marshall R. Hathaway	4197	July 9, 1877	16 18
4,654	M. Spurgeon	4235	July 16, 1877	160 00
4,655	John M. Shaw and six others	4655	July 17, 1877	1,591 38
4,651	Nelson Hoyt	4243	July 18, 1877	203 33
4,659	Oscar O. Gamyard	4323	Aug. 6, 1877	240 00
4,662	John Z. Wright, administrator of the estate of M. D. Swegget, deceased	4328	Aug. 6, 1877	33 33
4,663	John M. Breck	4318	Aug. 4, 1877	62 69
4,661	C. S. Drew	4321	Aug. 6, 1877	178 80
4,668	Abraham Fox	4322	Aug. 6, 1877	405 36
4,567	C. W. Noblitt	4326	Aug. 6, 1877	74 40
4,665	Charles Hubbard	4324	Aug. 6, 1877	27 24
4,660	Thomas W. Beal	4332	Aug. 7, 1877	272 60
4,666	L. Scovell	4327	Aug. 6, 1877	69 33
4,669	Monteith & Co	4325	Aug. 6, 1877	26 66
4,664	William Cantrall	4333	Aug. 7, 1877	15 20
4,647	Silas D. Maxon, V. Probstel, Joseph Stanley, John McPherson, and Jos. Caples	4388	Aug. 10, 1877	788 79
4,658	Benjamin F. Goodwin	4450	Aug. 21, 1877	323 75
4,675	Joseph W. Drew	4647	Oct. 11, 1877	234 17
4,657	R. G. Allen, deceased, by Benjamin G. W. and R. G. Allen, heirs	4193	July 6, 1877	38 83
4,677	Johnson & Perkins	4773	Oct. 31, 1877	350 00
4,676	John Pritchett	4774	Oct. 31, 1877	161 67
4,673	George Wood	4775	Oct. 31, 1877	346 80
4,639	Richard Covington	4792	Nov. 8, 1877	42 00
4,670	Isaac Miller	4794	Nov. 8, 1877	276 66
4,674	Andrew Jackson Young	4794½	Nov. 8, 1877	270 00
4,671	N. P. Briggs	4791	Nov. 8, 1877	134 50

Schedule of claims, &c.—Pay, transportation, services, and supplies of Oregon and Washington Territory Volunteers in 1855, '56—Continued.

No. of claim.	Name of claimant.	No. of sett.	Date.	Amount.
4,678	R. C. Hill, administrator of the estate of Elijah Hill, deceased	4793	Nov. 8, 1877	$72 15
4,656	Joseph Whitaker, (omitted to be entered in its proper order)	4194	July 6, 1867	58 46
4,679	William H. Perkins and others	4824	Nov. 12, 1877	220 33
4,682	Laban B. Fry, deceased, and others	4879	Nov. 14, 1877	502 80
4,680	W. M. Powers	4894	Nov. 19, 1877	150 00
4,681	Jacob McKinney	4893	Nov. 17, 1877	15 86
4,640	Isaac Springer, $300; Joseph Latshaw, $232; Francis F. Loehr, $927 43; E. L. Massey, $157 04; Thos. B. Scott, $65 34	4902	Nov. 20, 1877	1,681 81
4,648	Jacobs & Harbaugh	4901	Nov. 20, 1877	272 66
4,672	Erastus Holgate, $30; John McCoy, $15 63; Martin Luper, $25; Christian Farlow, $26 66; William F. Dixon, $131 12; Hugh Lee, $91 65	4900	Nov. 20, 1877	320 06
4,685	John M. Wallan, $291 67; George W. Olds, $46 66	5049	Dec. 6, 1877	338 33
4,684	John Perkins	5219	Dec. 22, 1877	7 60
4,687	Antoine Martineau	5220	Dec. 22, 1877	65 68
4,688	John F. Sutherlan and Matthew Adams	5221	Dec. 22, 1877	86 63
4,686	Jabez Huelat	5259	Dec. 27, 1877	1,176 52
	Total			17,759 69

APPENDIX B.

TREASURY DEPARTMENT,
First Comptroller's Office, January 26, 1878.

List of accounts of lands erroneously sold reported upon and certified to this office by the Commissioner of the General Land Office, withheld for Congressional action, the basis for rejecting such accounts being the date of cancellation. (*See page* 12.)

No. of report.	State.	Name.	Cancelled.	Amount.
31,593	Alabama	Thomas M. J. Porter, assignee	Oct. 8, 1858	$60 15
31,464	....Do	David Walker	May 24, 1861	40 00
31,520	....Do	James B. Cook	Oct. 8, 1858	159 84
31,521	....Do	Edward F. Baun	Oct. 8, 1858	39 84
31,524	....Do	Nathaniel R. Daniel	Oct. 8, 1858	160 64
31,525	....Do	Richard Z. Foster, assignee	Oct. 8, 1858	160 78
31,526	....Do	Samuel Canthon	Oct. 8, 1858	79 88
31,527	....Do	John T. Long, assignee	Oct. 8, 1858	159 68
31,528	....Do	William F. Wallace	Oct. 8, 1858	167 14
31,594	California	Patrick Lynch	Nov. 7, 1874	200 00
31,353	Florida	William F. Russell	Sept. 5, 1850	202 85
31,595	Minnesota	Walter Gorman	Apr. 7, 1873	11 00
31,636	....Do	Jonas Erickson	June 24, 1873	31 00
31,635	Missouri	Price Vestal	Sept. 11, 1860	30 00
31,597	....Do	James Brown, assignee	Mar. 4, 1875	200 00
31,433	....Do	Thomas Ervin	Sept. 11, 1860	40 00
31,603	Nebraska	Addison Carr	May 10, 1875	100 00
31,631	Wisconsin	Joanna E. Springer	Mar. 11, 1872	50 00
	Total			1,892 80

The following additional accounts were included in the amount presented to Congress in the special estimates of October 15, 1877, for appropriation under the head of "Refunding money for lands erroneously sold:"

No. of report.	State.	Name.	Cancelled.	Amount.
30,783	Alabama	Calvin L. Arant	Oct. 8, 1858	$150 18
30,969	....Do	Geo. T. Burke, administrator.	Oct. 8, 1858	160 03
30,970	....Do	Matilda D. Smith, executrix	Oct. 8, 1858	159 17
30,833	Arkansas	Angus McDonald	Feb. 5, 1873	50 00
30,860	....Do	D. S. Greer, administrator	Sept. 24, 1874	200 00
30,876	....Do	Reuben Riggs	May 6, 1870	40 00
30,874	....Do	Thos. C. McRae, adm'r	June 4, 1860	100 00
30,888	....Do	E. T. Richards	Oct. 23, 1874	10 00
31,209	....Do	William H. Pittman	....	30 00
30,838	California	Francis M. Kittridge	May 15, 1873	116 44
30,972	....Do	Robert Anderson	July 9, 1872	400 00
31,182	....Do	Talitha Matthews, adm'r, &c.	Dec. 11, 1872	41 70
31,187	....Do	A. Hewel	July 14, 1874	100 00
31,198	Colorado	John Tittman	Mar. 26, 1873	205 26
31,117	Illinois	Chas. Henrotin, attorney	Nov. 11, 1857	200 00
30,829	Kansas	John H. Rudloff	Sept. 18, 1873	19 40
30,798	Michigan	Lorenzo Anthony	Dec. 12, 1859	31 44
30,835	....Do	Isaac M. and D. F. Weston, assignees.	Jan. 26, 1869	102 22
31,131	....Do	Alfred N. Lawrence, self and assignees.	May 12, 1874	400 00
31,136	....Do	D. Stewart, president, &c	Aug. 29, 1871	222 81
31,151	....Do	N. Ludington and E. H. Denison, &c.	Aug. 29, 1871	500 00
31,796	Minnesota	O. B. Sturtevant	June 30, 1873	33 50
31,132	....Do	James G. Butterfield	July 16, 1874	200 00
31,193	....Do	Niles Nilsson	Dec. 18, 1873	17 19
30,822	Missouri	Adam C. Dyas, administrator	July 17, 1860	8 15
30,849	....Do	Willis Burk	Mar. 1, 1870	34 61
31,130	...Do	Joel W. Thomas	Aug. 30, 1871	53 12
31,204	....Do	G. C. Land	April 26, 1871	100 00
31,208	....Do	Geo. W. Dickson	Sept. 1, 1870	50 00
30,839	Mississippi	James R. Crosby	June 25, 1859	30 15
30,834	....Do	Geo. B. Harper, adm'r	June 25, 1859	120 63
31,129	Montana	L. B. Lyman, assignee, &c	Oct. 14, 1874	175 19
30,872	Nebraska	Chas. S. Demary	Aug. 30, 1871	50 00
30,841	Washington Ter.	Lawrence Nessell	June 25, 1872	75 62
30,830	Wisconsin	D. W. Smith	April 22, 1873	46 55
30,853	...Do	Alex. and D. D. McMillan	Mar. 13, 1869	50 00
31,189	....Do	Fred. Carney	Feb. 18, 1873	50 00
	Total			4,333 36

45TH CONGRESS, 2d Session. } HOUSE OF REPRESENTATIVES. { Ex. Doc. No. 47.

PAINTING TENDERED CONGRESS BY MRS. ELIZABETH THOMPSON.

MESSAGE

FROM THE

PRESIDENT OF THE UNITED STATES,

INFORMING

Congress that he had delivered to Mrs. Elizabeth Thompson a copy of the joint resolution of Congress accepting a painting tendered by her.

FEBRUARY 11, 1878.—Referred to the Committee on the Library and ordered to be printed.

To the Senate and House of Representatives:

In compliance with the resolution of Congress entitled "Joint resolution accepting a painting tendered to Congress by Mrs. Elizabeth Thompson," approved by me on the 1st instant, I have this day caused a copy of the resolution to be delivered to Mrs. Thompson.

R. B. HAYES.

EXECUTIVE MANSION, *February* 11, 1878.

COMMUTATION ALLOWED OFFICERS IN CERTAIN CITIES.

LETTER

FROM

THE SECRETARY OF WAR,

TRANSMITTING

A list of officers who received commutation fuel, forage, and quarters in certain cities.

FEBRUARY 13, 1878.—Referred to the Committee on Military Affairs and ordered to be printed.

WAR DEPARTMENT,
Washington City, February 11, 1878.

The Secretary of War has the honor to transmit to the House of Representatives, for the Committee on Military Affairs, in compliance with a request of Hon. E. S. Bragg, of subcommittee, for certain information as to the number and grade of officers who received allowance for fuel, forage, and quarters in Washington, New York, Chicago, and Saint Paul, and the amount paid monthly for quarters in said cities, a report of the Quartermaster-General on the subject.

GEO. W. McCRARY,
Secretary of War.

To the SPEAKER
of the House of Representatives.

WAR DEPARTMENT,
QUARTERMASTER-GENERAL'S OFFICE,
Washington, D. C., February 6, 1878.

SIR: Referring to a letter of February 4, 1878, addressed to the Quartermaster-General, United States Army, from the Hon. E. S. Bragg, Subcommittee on Military Affairs, House of Representatives, requesting the following information, viz:

1st. The number and grade of officers who received allowance for fuel, forage, and quarters in the cities of Washington, New York, Chicago, and Saint Paul, classifying in each of said cities separately.

2d. The total paid monthly for quarters in each of said cities, stating for each city separately.

4th. What law or authority exists authorizing such payments—

I have the honor to inclose herewith a statement of the number of officers on duty in the cities of Washington, New York, Chicago, and

Saint Paul who receive fuel, forage, and quarters from the Quartermaster's Department, showing the amount paid by officers of the Quartermaster's Department to the owner of quarters occupied by them in the month of December, 1877, that being the last month for which complete returns have been received at this office, classified separately, as requested.

The law authorizing the supply of fuel, forage, and quarters is to be found in the act of 15th July, 1870, section 24, and also in section 1270, Revised Statutes, as follows:

> Fuel, quarters, and forage may be furnished in kind to officers by the Quartermaster's Department according to law and regulations.

This law is carefully administered. Since it was enacted commutation of quarters, fuel, and forage to officers has ceased.

Under section 24 of the law of 15th July, 1870, and section 1273, Revised Statutes, quartermasters are forbidden to make any payments of public money to officers of the Army on any account whatever. The Quartermaster-General understands and believes that one at least of the objects of this enactment was to enable Congress by calling upon a single office, that of the Paymaster-General, to ascertain what public money was actually paid during any period of time to any or all officers of the Army.

Very respectfully, your obedient servant,

M. C. MEIGS,
Quartermaster-General U. S. A.

To the Hon. SECRETARY OF WAR.

Statement of the number of officers on duty in the cities of Washington, New York, Chicago, and Saint Paul who receive fuel, forage, and quarters in kind, with the number of each rank, also the amount paid for quarters in the month of December, 1877, in each of said cities.

WASHINGTON, D. C.

[Act approved July 25, 1866, and section 1270, Revised Statutes.]

No. of each.	Grade.	No. of rooms.	Rent.
1	General	....	$250 00
9*	Brigadier generals	45	810 00
13	Colonels	65	1,170 00
3	Lieutenant-colonels	12	216 00
23	Majors	92	1,656 00
6	Captains	18	324 00
18	Lieutenants	36	648 00
7	Acting assistant surgeons	14	126 00
80		282	5,200 00

NEW YORK CITY.

1	Major-general	6	$108 00
11	Colonels	55	990 00
5	Lieutenant-colonels	20	360 00
14	Majors	56	1,008 00
9	Captains	27	486 00
5	Lieutenants	10	180 00
45		174	3,132 00

*Including Brig. Gen. G. R. Paul, retired February 16, 1865; he was granted full pay and allowances of a brigadier-general under authority conferred by resolution of the Senate and House of Representatives, approved April 12, 1870.

Statement of the number of officers on duty in the cities of Washington, New York, &c., who receive fuel, forage, and quarters, &c.—Continued.

CHICAGO.

No. of each.	Grade.	No. of rooms.	Rent.
1	Lieutenant-General	6	$108 00
3	Colonels	15	270 00
5	Lieutenant colonels	20	360 00
6	Majors	24	432 00
2	Captains	6	108 00
2	Lieutenants	4	72 00
19		75	1,350 00

SAINT PAUL.

No. of each.	Grade.	No. of rooms.	Rent.
1	Brigadier-general	5	$90 00
1	Colonel	5	90 00
2	Lieutenant-colonels	8	144 00
7	Majors	28	504 00
5	Captains	15	270 00
4	Lieutenants	8	144 00
20		69	1,242 00

TOTAL.

Cities.	No. of officers.	No. of rooms.	Rent.
Washington	80	282	$5,200 00
New York	45	174	3,132 00
Chicago	19	75	1,350 00
Saint Paul	20	69	1,242 00
Total in the four cities	164	600	10,924 00

Quarters, fuel, and forage are allowed and supplied to officers of the Army under section 24, act of July 15, 1870, also section 1270 Revised Statutes.

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RESERVOIRS TO PROMOTE THE NAVIGATION OF THE MISSISSIPPI RIVER.

LETTER

FROM

THE SECRETARY OF WAR,

TRANSMITTING

Information concerning the effect of reservoirs upon the navigation of the Mississippi River.

FEBRUARY 13, 1878.—Referred to the Committee on Commerce and ordered to be printed.

WAR DEPARTMENT,
Washington City, February 11, 1878.

SIR: In compliance with the joint resolution of Congress approved December 15, 1877, "relative to reservoirs to promote the navigation of the Mississippi River," I have the honor to transmit herewith a communication from the Chief of Engineers of the 8th instant, and copies of the report on the subject from Majors Houston and Farquhar, of the Corps of Engineers.

Appendix C C, report of the Chief of Engineers for 1875, and Appendix T 2, of his report for 1876, are herewith transmitted.

Very respectfully, your obedient servant,

GEO. W. McCRARY,
Secretary of War.

The SPEAKER *of the House of Representatives.*

OFFICE OF THE CHIEF OF ENGINEERS,
Washington, D. C., February 8, 1878.

SIR: To comply with the provisions of the joint resolution of Congress "relative to reservoirs to promote the navigation of the Mississippi River," approved December 15, 1877, which was referred to this office for report, I beg leave to submit a copy of a communication from Major D. C. Houston, Corps of Engineers, upon so much of the same as refers to the preliminary examination of the headwaters of the Wisconsin River, and a copy of a letter from Major F. U. Farquhar, Corps of Engineers, upon that portion which relates to the examination of the headwaters of the Saint Croix and Chippewa Rivers.

These reports are necessarily meager and indefinite, for the reason that no funds were available for making the examinations requisite to procure information, as well as for lack of time; but they will, it is hoped, furnish sufficient data upon which to base an estimate of the amounts that will be required for making adequate surveys for ascertaining the extent and practicability of the proposed reservoirs.

The question of the improvement of the navigation of Western rivers by means of reservoirs has attracted the attention of this office, and estimates have been submitted for the necessary surveys for ascertaining their practicability, cost, &c., as may be seen by reference to the reports of the Chief of Engineers for 1869, pages 188, 189; for 1870, page 291; for 1875, part 2, page 434 *et seq.*, and for 1876, part 2, pages 288–9.

Appendix C C, report of 1875, and Appendix T 2, report of 1876, are herewith.

No appropriations have been made for the surveys in question.

The joint resolution is herewith respectfully returned.

Very respectfully, your obedient servant,

A. A. HUMPHREYS,
Brigadier-General and Chief of Engineers.

Hon. GEO. W. MCCRARY,
Secretary of War.

RESERVOIRS ON THE HEADWATERS OF THE WISCONSIN RIVER TO PROMOTE NAVIGATION OF THE MISSISSIPPI RIVER.

UNITED STATES ENGINEER OFFICE,
Milwaukee, Wis., January 21, 1878.

GENERAL: I have the honor to submit the following report in reference to reservoirs on the headwaters of the Wisconsin River for the improvement of the Mississippi River, called for by your letter of the 2d instant, inclosing copy of resolution of Congress, entitled:

Joint resolution relative to reservoirs to promote the navigation of the Mississippi River. Approved December 15, 1877.

There being no funds applicable to a full examination of the country necessary to determine the questions involved, and if there were, the time allowed not being sufficient to make such an examination, this report is necessarily limited to presenting such information as now exists, and I am able to obtain by inquiry of persons familiar with the locality.

There is no survey (to my knowledge) of the Upper Wisconsin, except the United States land-survey, which simply gives the course of the stream, and contains no information of any value whatever in this connection.

The only report I can find which gives any information in reference to the character of the Upper Wisconsin and the adjacent country is that of Dr. J. G. Norwood, which is found in Owen's report on the geology of Wisconsin, Iowa, and Minnesota, published under direction of the Commissioner of the General Land Office, by Lippincott, Grambo & Co., Philadelphia, in 1852.

Dr. Norwood made a journey in 1847 from Lake Superior to the headwaters of the Wisconsin River and descended the river in a canoe from a point where it was but 12 yards wide to its mouth.

I forward herewith a copy of his itinerary from the starting-point to

Grand Rapids, which embraces the only portion of the river where reservoirs in this connection are deemed practicable.

This part of the river runs over the crystalline rocks; below Grand Rapids the country is sandy, the bed of the river being filled with sand-bars, rendering the formation of reservoirs for the purpose proposed impracticable. In view of the condition of settlements in the country I judge that any reservoirs must be located above the mouth of Prairie River, in the southern part of Lincoln County.

Dr. Norwood describes this portion of the river as a succession of rapids. In a number of places the river passes through high rocky ranges where these rapids or falls are found.

It would appear from his report that there are several places where reservoirs of large capacity could be created.

His remarks on the general features of the country would indicate that it was practicable to dam up the river at different points, and probably some of the tributaries, so as to form reservoirs of any required extent sufficiently so to warrant a thorough examination of the country with a view to the location of reservoirs should such a system be thought advisable.

Dr. O. W. Wight, formerly State geologist of Wisconsin, who visited the upper waters of the Wisconsin in 1875, informs me from his knowledge of the country that it is entirely practicable to create reservoirs in that region of any needed extent.

His plan would be to construct dams at the outlets of some of the numerous lakes which discharge their waters into the Upper Wisconsin. This, he thinks, can be done at reasonable cost, and that very little land would be flowed.

I inclose report of Mr. E. C. Hinman, overseer, giving results of his inquiries of persons at Portage City and Stevens's Point.

From the information I have gained I am of the opinion that at a moderate cost reservoirs can be created on the headwaters of the Wiscansin River which would be of great service in connection with the method of improvement by wing-dams in making that river navigable at all seasons of the year, and contributing with reservoirs on other tributaries to the improvement of navigation on the Mississippi.

A survey including measurements to ascertain the volume of discharge of the river and its tributaries is necessary to determine, even approximately, the extent of such reservoirs and the character and value of land which would be submerged.

I am, general, very respectfully, your obedient servant,

D. C. HOUSTON,
Major of Engineers.

Brig. Gen. A. A. HUMPHREYS,
Chief of Engineers, United States Army.

REPORT OF MR. E. C. HINMAN, OVERSEER.

PORTAGE, WIS., *January* 17, 1878.

SETTLEMENTS AND MILLS ABOVE STEVENS'S POINT.

The settlements above Stevens's Point are all lumbering towns, arranged up the river in the following order:

1. Eau Pleine, 12 miles above Stevens's Point; population, 509.
2. Knowlton, 18 miles above Stevens's Point; population, 264.
3. Mosinee, 26 miles above Stevens's Point; population, 200.

4. Wausau, 41 miles above Stevens's Point; population, 1,500.
5. Jenny, 56 miles above Stevens's Point; population, 700.

Jenny is the most northern town on the Wisconsin River. It is 12 miles from Jenny to Grandfather Bull Falls. The mills between Stevens's Point and Jenny are located on tributaries of the Wisconsin River, near their mouths, and at the several villages on the main river. They are located as follows (going up the river):

Little Eau Pleine River: 1 steam-mill; 1 water-mill.
Little Eau Claire River: 1 steam-mill; 1 water-mill.
Knowlton (village): 2 steam-mills.
Big Eau Pleine River: 1 steam-mill.
Mosinee village: 1 steam-mill; 1 water-mill.
Big Eau Claire River: 2 water-mills.
Big Sandy River: 1 water-mill.
Wausau (village): 1 steam-mill; 4 water-mills.
Little Rie River: 1 steam-mill.
Trap River: 1 steam-mill.
Pine River: 1 water-mill.
Jenny (village): 1 water-mill.

Jenny is the most northern point on the Wisconsin River where lumber is manufactured.

The country is settled between Stevens's Point and Jenny, but above this point it is unsettled, except by lumber-camps, Indians, and trappers.

CUTTING TIMBER.

Timber has been cut on all of the headwaters of the Wisconsin as far north as "Lac Vieux Desert," and on all tributaries east and west.

DESCRIPTION OF LAND BORDERING THE HEADWATERS OF THE WISCONSIN RIVER.

Nearly all of the land along this portion of the river and its tributaries is entered for the pine growing upon it. This land is low, marshy, and mostly impassable, except in winter. There are tracts of marsh-land covered with grass; also some upland covered with hard-wood timber. The (pine) land that would be flooded is held by the owners only for the timber with which it is covered, and when that has been cut, the owner generally abandons the land, when it reverts to the State. This land, while timbered, is valued according to the estimated amount of manufactured lumber it will yield, to its nearness to the river, improvements made upon it or for it, such as building roads, bridges, and dams, to assist in driving logs. The present value ranges from $1 to $2 per thousand "stumpage", being so much per thousand feet estimated standing on the land.

RIVER-IMPROVEMENT COMPANY.

There is a chartered river-improvement company, which has for its object the improvement of the numerous rapids in the Wisconsin River, by means of dams, to facilitate in driving logs and running lumber over them. This company have put in dams at Grandfather Bull Falls, Big Bull Falls, Little Bull Falls, and other smaller rapids on the river and its tributaries. Tolls are collected on all lumber and logs passed over the sections of river thus improved.

GRANDFATHER BULL FALLS.

These falls in the Wisconsin River are 15 miles above Jenny. They are the largest on the river, are 1¼ miles long, and fall 105 feet in the whole length. The river at this point is about 500 feet wide, the banks on each side, as well as the bed of the river, are of granite rock. The banks are from 20 to 40 feet high. Here would be the most favorable point on the Wisconsin River for a dam of masonry, on account of the natural rock foundation and abutments. The river is very rapid above the falls, and there are two smaller rapids at 6 and 12 miles, respectively, above Grandfather Bull Falls. The land has been cleared of pine to from 2 to 4 miles back from the river. The land ascends from the river gradually.

On account of the swift current and rapids above, and the consequent sudden ascent in the land going up stream, the question arises, Would a dam bank high on the crest of Grandfather Bull Falls create a reservoir of sufficient capacity to hold enough water in time of a freshet to materially benefit navigation? Lumbermen acquainted with the river at this point give opinions both in favor of and against the practicability and extent of such a reservoir, although a thorough investigation might result favorably.

EAGLE RIVER.

The Eagle River is a tributary of the Wisconsin, has its source in Marathon County, runs through a chain of large lakes, and joins the Wisconsin in township 40 north, range 10, section 31. It is a wide, deep stream. The land bordering it is timbered with pine and hard wood. Considerable pine timber has been cut three-quarters of a mile above its mouth. The banks are from 18 to 20 feet high, composed of "hard-heads" and gravel. The bed of the river is of the same material. The river at this point is estimated to be 400 feet wide. The land ascends from the river. A dam at this point could be constructed that would set back the water of the river into Catfish, Yellow Birch, Eagle, Cranberry, and several smaller lakes.

There is a fall from Long Lake into Cranberry, at which point a dam could be constructed which would raise Long Lake several feet. It is estimated that these two dams would flow an area equal to three townships. The natural lakes cover one and a half townships.

It was estimated by the River-Improvement Company herein mentioned that a dam 8 feet high at the point designated on Eagle River would hold back water enough to make a three weeks' freshet in the Wisconsin River.

PELICAN RIVER.

The Pelican River is a tributary of the Wisconsin; it rises in Marathon County, runs through several lakes, and empties into the Wisconsin in township 36 north, range 9, section 6. There are rapids near its mouth, but above them the river is sluggish. At the upper rapids the banks are 15 feet high, composed of rocks and gravel, as is the bed of the river. Estimated width of river 200 feet.

It is thought a dam constructed at this point would create a large reservoir, having an area equal to two townships. There is pine timber along this stream, and considerable logging has been done on it. There is a large tract of land without timber, the most of which is entered for hay land.

TOMAHOCK RIVER.

This river, a tributary of the Wisconsin, is a lumbering stream. It has its source in "Tomahock" Lake. It is without rocky banks at *one point* on both sides, and is not recommended as a good site for a reservoir. However, it might be possible to make a large reservoir on this river in conjunction with the headwaters of the south fork of the Chippewa River; but it is impossible from data at hand to determine to what extent.

GENERAL.

There are several other prominent tributaries of the Wisconsin River, on some of which large reservoirs could probably be made, but no favorable information could be obtained concerning them.

The opinion is prevalent that lumbermen would gladly relieve the United States from claims for damage to land on the site of contemplated reservoirs on account of the benefits which would be rendered them in driving logs and running lumber.

SOURCE OF INFORMATION.

This report is made up from information obtained in interviews on the subject with the following gentlemen, who concur in the practicability of reservoirs to the extent herein set forth: Hon. A. Eaton, land agent, Wisconsin Central Railroad, who was for fourteen years receiver of the United States land-office, Stevens's Point; Mr. E. A. Williams, surveyor and land-looker; Mr. A. J. Hammacker, merchant, Stevens's Point, connected with the improvement company, and familiar with the Wisconsin River and its tributaries; John Hawn, Stevens's Point, lumberman, land-looker, and guide, who has traversed the whole territory in question; William Hayes, Portage, raft-pilot.

Respectfully submitted,

ED. C. HINMAN,

Overseer Fox and Wisconsin Rivers Improvement.

EXTRACT FROM NARRATIVE OF EXPLORATIONS MADE IN 1847 BETWEEN PORTAGE LAKE AND THE HEADWATERS OF WISCONSIN RIVER AND DOWN THAT STREAM TO WINNIBAGO PORTAGE.—BY DR. J. G. NORWOOD.

[See Owens's Geological Survey of Wisconsin, Iowa, and Minnesota, published under direction of the Commissioner of the General Land Office, in 1852, by Lippincott, Grambo & Co., Philadelphia.]

* * * * * * *

October 2.—The ground was whitened by a heavy frost, and the atmosphere cool and bracing. Muscle Lake, upon which we began our voyage to the Mississippi, is about

one mile long and rather more than half as broad. A small stream about 150 yards in length led us into another lake rather more than half a mile in diameter. It discharges its waters into the Wisconsin River through a small creek from one to five yards wide, running east. The creek is very shallow, very crooked, and much obstructed by drift-wood, but without a rock of any description. Its whole course is through swamps, bordered by sand-banks covered with pine. The banks have quite a reddish appearance, although the sand in the bed of the river is white. The entire bed of the creek in many places is covered by several species of Unio.

At half past twelve o'clock we entered Wisconsin River, which is 12 yards wide at the junction, and from 3 to 4 feet deep. Its course is south for several miles, but gradually changes to southwest, which was the prevailing course during most of the afternoon.

We encamped about eighteen miles below the mouth of Muscle River, although in a direct line, probably not more than six or seven miles, as the river is remarkably crooked. It is from 10 to 15 yards wide, and is occasionally obstructed by drift-wood. We did not see a rock or pebble of any kind until just before reaching our camping-ground, when a solitary bowlder showed itself, and a few minutes afterward the shores were found lined with pebbles washed out of the banks, which are composed of sand, and are from 3 to 20 feet high, and covered with pine, fir, and spruce, with a few aspens and small birch. The low grounds, which frequently intervene between the river and the high banks, support elm, and, where very low, tamarack in abundance. The margin of the water is overhung by alders and cranberry bushes. At one point the drift was seen resting on a bed of reddish-colored indurated clay. The banks where slides have taken place present all the appearance of stratification, with a dip to the south greater than the fall of the river. A few first-rate and many second-rate pines were seen.

October 3.—We left camp at 8.30 a. m., and at 1.30 p. m. reached the first rapids. They are made by a low range of gneiss and gneissoid granite, bearing northeast and southwest, and are half a mile long. The fall is not very great, but the navigation was rendered rather difficult by the great number of bowlders, some of them very large, which cover the bed of the river for nearly the whole distance. Above the rapids the river is 50 yards wide; below them it contracts again to 30 yards in width.

Three other rapids occur in the distance of a mile and a half. The first one is short but difficult to pass. The river is divided by a small island at the foot of the rapid. The channel for canoes is on the east side of the island. The second one is made up of granite, with gneiss resting on it; and the third of gneiss and hornblende. In the forenoon the river was much obstructed by drift-wood, and was very crooked except in the vicinity of the rapids, where its channel lay for some distance between the elevated ridges of rock. The country for a short distance above and opposite these rapids is open, bearing thickets of small birch, and a few stunted pines scattered through them. Occasionally a solitary large pine was seen standing on a sandy knoll, 20 or 30 feet above the level of the river. Below the last rapids the country is made up of sand, apparently destitute of pebbles, with sandy loam on top, and supporting a tolerably good growth of pine, birch, and aspen.

October 5.—Ninety-six miles (according to our estimate of distances) below the mouth of Muscle River, we came to a high range of rocks consisting of hornblende, gneiss, and gneissoid granite. This range about 150 feet high, bearing northeast and southwest. The rapids formed by it have a descent of about 30 feet in a quarter of a mile. The portage-path is on the east side of the river, and is about 500 yards long.

On a small prairie, half a mile from these rapids, I measured a granite bowlder 78 feet in circumference and 10 feet high.

The rocks continued to show themselves until, ten miles below the last range, we came to one about 300 feet high, composed of syenite and greenstone, traversed by veins of feldspar, quartz, granite, and titaniferous iron. The granite veins are from 2 to 3 feet in width and porphyritic.

The average width of the river yesterday was from 40 to 50 yards. The banks were of sand, from 10 to 30 feet in height, and exhibit at some points extensive slides, similar to those seen on the Chippewa, below the dalles of that river.

I made an excursion into the country yesterday, commencing at the foot of a large island, the first one of any size met with in descending the river. I proceeded directly west, and found the country to present a succession of low ridges, and tamarack swamps. The ridges are sandy, with a thin soil, and from a quarter to half a mile wide. On the more elevated grounds are some first-rate, and a great number of second-rate pines.

A few miles south of this the Kewaykwodo portage begins. It passes for some distance over a rolling sandy country, which is the general character of the region bordering the river for some miles above and below the beginning of the portage. A narrow strip of small pines lines the banks of the river at intervals, but as you recede into the country there are few trees of any size to be seen. Clumps of very small birch and pine are scattered over it. This portage leads to Lac du Flambeau, by way of Swamp, Kewaykwodo, Leech, Thesebagomag, Wishekon, and La Roche qui Traine

Lakes. Just below the Kewaykwodo portage, the river is filled with bowlders, some of which are very large.

The banks of the river to-day were of fine drift, generally from 3 to 8 feet high, and resting on a bed of red clay, the thickness of which is not known, as it only rises from 12 to 18 inches above the water-level. It is stratified, exceedingly compact, and in seams about an inch thick. Some of the ridges, sections of which are made by the river, are from 50 to 60 feet high, and composed entirely of sand, with pebbles and a few small bowlders near the top.

October 6.—About eight miles below the last high range we came to one about 150 feet high, composed of the same kind of rocks, syenite and hornblende. The rapids at this place are half a mile long, with an island dividing them at the lower end. At the foot of the island the water falls 2½ feet perpendicular. There is a portage-path on the east side of the river. One canoe, however, descended the rapids without much difficulty.

There is a succession of small rapids for the next four miles, the rocks showing themselves in the borders of the river at short intervals the whole distance. The river is very shallow, very wide, and the bed covered with bowlders, many of which are from 30 to 50 feet in circumference. In the afternoon we reached a point where the river is from 400 to 500 yards wide. Up to this point it has been so shallow below the last rapids as to allow the canoe to pass with difficulty. Here it is deep, with no perceptible current, and continues so for about six miles, when it is again obstructed by bowlders and a succession of rapids, which continue for about eight miles, the rock showing itself in place at several points in the middle of the river.

The rocks are fine-grained granite, hornblende, and porphyritic syenite in low ranges, all bearing northeast and traversed by wide quartzose veins. The country, with the exception of the rocky ranges, is, in the immediate neighborhood of the river, mostly broken sand-prairie, with a few small pines scattered here and there; and occasionally a few shrubby oaks, small birch, and aspen show themselves.

The ridges are denseely timbered with hard and soft woods, among which, when the rocks approach the surface, a great deal of fine cedar is found. The river-bottoms, which are sometimes from a quarter to half a mile wide, are timbered with oak and elm of good size or covered with a luxuriant growth of grass.

October 7.—We left camp this morning at seven o'clock, and two miles below came to a low range of trap-rocks bearing northeast and southwest, and making rapids. One mile below this we reached the largest rapids of Wisconsin River, known among the traders and lumbermen as "Grandfather Bull Falls." A fine section is exposed at this place. The top of the ridge is about 150 feet above the level of the water, which cuts through the rocks for the distance of a mile and a half.

The fall of the water in this distance I had no means of ascertaining. At the upper part of the rapids the river is divided into three chutes by two chains of rocks, which rise from 10 to 15 feet above the water, and continue for some distance below the commencement.

The rocks on the north side of the range are greenstone-trap, protruding through gneiss and hornblende slate, while the lower part of the rapids is made by gneiss, interstratified with mica slate and talcose slate. The stratified rocks above the rapids have a dip of 20° to the northwest. The river falls, for a great part of the distance, in a succession of small cascades, made by the tilted strata extending across the river in the line of bearing. A few of the cascades are 7 or 8 feet high, but generally from 2 to 5 feet, and from 60 to 80 yards apart. At the foot of the falls the gneiss and mica slate dip 57° southeast.

Four miles below the falls we reached the mouth of Skakweya or New Wood River, and, much to our joy, found a trading-house established there. The person who occupies it intends opening a farm, and has already made a small clearing. We obtained from him some pork and a lot of fine potatoes. As we had been without meat for several days, we found the sour pork quite palatable. The potatoes, which were raised here, are equal to any I have ever seen.

About a mile and a half below the mouth of New Wood River a number of springs, strongly impregnated with iron, burst out of the west bank of the river. As the springs are but a few feet above low-water mark, every rise of the river carries away most of the ferruginous matter deposited; still there is a deposit of considerable thickness lining the shore for the distance of a quarter of a mile. The hill in which the springs originate is about 80 feet high, and extends back from the river from a quarter to half a mile to a deep ravine into which springs discharge from the same hill, but present no indication of iron whatever.

At the mouth of Copper Rock River, 5 miles below the mouth of New Wood River, a trap-dike crosses the Wisconsin, making an island in the river, 30 feet high, known as Rock Island. This range makes dalles on Rock River several miles above its mouth. The walls of rock at the dalles are from 40 to 50 feet high, and at one point approach within 6 feet, through which contracted space the water rushes with great swiftness. There is a portage of twelve miles from the mouth of the river to a point above the

dalles. The river is then navigable for canoes to the lake of which it is the outlet, a distance of about 40 miles. Greenstone continues to show itself in the river, without forming rapids, for the next three miles.

Six miles below the mouth of Rock River, Prairie River comes in from the east, and just below its mouth a range of hornblende-trap crosses the Wisconsin, bearing east-southeast and west-northwest, forming Beaulieux's Rapids. At one point in these rapids there is a fall of 4 feet, affording excellent facilities for driving machinery.

Seven miles below these rapids, near the mouth of Pine River, trap shows itself in the bed of the river without obstructing navigation. About 4½ miles below the mouth of Pine River, Trap Rapids begin, and immediately below them a reddish-colored, compact, fine-grained granite shows itself in the banks of the river. Three miles further a range of hills from 350 to 400 feet high, and bearing northeast and southwest, skirt the river for some distance. They are, so far as observed, made up entirely of a greenish-colored, compact, petrosiliceous rock, fusible, with difficulty, before the blow-pipe into a colorless enamel, and resembles very much some trachytic specimens brought from the Euganean Hills, and from the Cantot. This rock extends to within a short distance of Big Bull Falls, and forms the most southerly range of hills in the eastern part of the Chippewa land-district, the corner of which strikes Wisconsin River, in latitude 45°, and about six miles above the falls.

We got to the falls early in the afternoon, and having made the portage around them, devoted the remainder of the day to procuring provisions for the further prosecution of our journey.

The village at the falls consists of a number of very good frame houses, and from its position with regard to the lumber trade, in connection with the productiveness of the soil in its vicinity, bids fair to become a place of considerable importance at no distant day. An effort is being made to lay out and open a road from Green Bay to this place, which, when completed, will materially accelerate the settlement of the country, not only by affording facilities for immigration, but also by reducing the cost of provisions, which at present is a serious matter to new-comers, who have to purchase almost everything for the first year.

One of the finest pine regions of Wisconsin enters the district at this point from the south, and extends for some distance above Spirit River. The general character of the lands, bordering Wisconsin River from near its source to the neighborhood of Grandfather Bull Falls, has been indicated. Below that point from a quarter of a mile to a mile back from the river, ridges, bearing maple and other hard woods, begin and extend back into the country for many miles, while between the river and maple lands good pine is abundant.

The rivers originating in the Chippewa land-district, down which logs can be run, are Rib, Trap, Rock, and New Wood Rivers. On all these streams first-rate pine abounds, and on all of them logging companies have been established.

The country between them is made up of maple-ridges, interspersed here and there with marshes.

Big Bull Falls are made by a ridge of syenite granite about 30 feet high, traversed by a dike of greenstone, and crossing the river with a bearing east-northeast and west-southwest.

The river is divided by an island, upon which three mills are erected. The perpendicular fall of the east chute is about four feet, that of the west chute about eight feet. The rocks have a dip of 24° to the northwest.

October 9.—Seven miles below Big Bull, a high granite range shows itself on the west side of the river; and at several other points between that and Little Bull Falls, a distance of 13 miles, are exposures of the same rock.

At Little Bull there is usually a portage made three-quarters of a mile long, on the west side of the river; but our voyagers descended the whole rapid in the canoe, with the exception of a few yards at the mill-dam. There is no perpendicular fall at this place; it is a mere rapid, falling, in its whole length of over half a mile, as nearly as I could judge, 8 or 10 feet. The rock is a dark grayish and greenish colored compact syenite. The range is rather low, the rock being elevated, at the highest points observed, only about 10 feet above the water-level.

October 10.—Nine miles below Little Bull, a low range of gneissoid granite is exposed, extending along the western shore of the river for the distance of 150 yards, bearing east-northeast and west-southwest, with a dip of 6° to the south-southeast. The rock is traversed by numerous quartz veins, from 1 to 4 inches wide, and running in the direction of the line of strike. The direction of the cleavage joints is 15° west of south, and due east and west. The rock is overlaid by 20 feet of fine drift, with a thin soil of sandy loam.

The country is gently undulating prairie, with clumps of very small pines scattered over it.

One mile below this we reached Du Bois's trading-house. About five miles below Du Bois's, the grayish-colored gneissoid granite is again exposed for some distance along the west bank of the river, succeeded by a very fine-grained reddish granite.

The rock is covered here with about 10 feet of fine drift, with a thin soil, supporting a small growth of oak, elm, and aspen, on the west side, while east of the river, a beautiful undulating prairie extends as far as the eye can reach.

One mile above Stevens's Point there is an exposure of hornblende slate for half a mile, succeeded by gneissoid granite, which extends for some distance below the village, forming rapids.

The bearing of the rocks is northeast and southwest. The country in the vicinity of this place is undulating, with a tolerably good soil, supporting a growth of oak, elm, maple, and a few pines.

Two miles further brought us to Conant's Rapids. This point is exceedingly interesting, not only on account of the great exposure of rock, but also in consequence of the foldings and contortions which have been produced in the stratified rocks at the time of the intrusion of the igneous rocks.

The prevailing rock is a very decomposable amphibolic gneiss, passing into a highly-ferruginous mica slate, green, brown, and reddish gray in different localities, and associated also with a very light-colored granitic gneiss. These rocks all have a vertical dip, and are compressed by lateral force into almost every possible wave-like form. Between the layers of gneiss, veins of feldspathic granite from 6 inches to 25 feet in width have intruded at intervals, and at many points overlie for a long space the vertical edges of the gneiss. Some of the veins are porphyritic. The direction of the plane of stratification is northwest and southeast.

Numerous veins of quartz and of feldspar, from an inch to an inch and a half in width, traverse both the stratified and intrusive rocks, and have a northeast and southwest direction. Camped one mile below the commencement of the rapids.

October 11.—There is a fine display of gneiss on an island opposite our camp. It is a gray-colored, very fine-grained, compact rock, with a few regular crystals of feldspar disseminated through it, bearing east-northeast and west-southwest, with a dip southeast of 19°. It is traversed by many granitic veins following the curvatures of the strata, and these veins are traversed in turn by veins of quartz from half an inch to an inch wide, having a northeast and southwest direction. The gneiss is overlaid for a considerable space at many points by a very fine-grained, reddish-colored granite.

About two miles below Conant's Rapids, and about one-fourth of a mile below the mouth of Plover River, the gneiss is again exposed, bearing northeast and southwest, with a dip of 45° southeast. There is no bending of the strata at this place, nor did I observe any intrusive rock. Below the mouth of Plover River the drift-banks rise on the east side of the Wisconsin to the height of 30 and 50 feet above the level of the water, and at the bends of the river sand-slides occur precisely like those seen on Chippewa River, some of which are more than half a mile in length. Very few pebbles are mixed with the sand. The country is a rolling sand plain, with a few pine bushes and dwarf oaks scattered over it.

The next exposure of rock is at the commencement of the Grand Rapids, about 12 miles below the mouth of Plover River. These rapids are 9 miles long. Their grandeur consists not in cascades or bold escarpments, but in their length and the great number of low, picturesque rock islands, covered with trees, which dot the river and divide it into numerous narrow channels or chutes. The rock is a very compact feldspathic gneiss, with occasional wide veins of granite traversing it, gradually assuming a true porphyritic character about the middle of the rapids, and toward their termination merging into a gneissoid granite, and finally, at the village of Grand Rapids, into a fine-grained, reddish-colored granite of precisely the same character with that which overlies the gneiss at Conant's Rapids. The bearing of the rocks is east-northeast and west-southwest.

* * * * * * *

RESERVOIRS ON THE HEADWATERS OF THE SAINT CROIX AND CHIPPEWA RIVERS TO PROMOTE NAVIGATION OF THE MISSISSIPPI RIVER.

UNITED STATES ENGINEER OFFICE,
Saint Paul, January 23, 1878.

GENERAL: I have the honor to acknowledge the receipt of letter from your office, dated January 2, 1878, inclosing Public Resolution No. 2, of the present Congress, and directing me to report on the subject of the extent and practicability of constructing reservoirs, &c., at the head-

waters of the Saint Croix and Chippewa Rivers from such information as I might have in my possession or could collect.

The only information I have is derived from the United States land-survey maps, and from conversations with persons who have gone through the country.

1.—THE SAINT CROIX RIVER ABOVE SAINT CROIX FALLS.

The Saint Croix River above the Saint Croix Falls drains an area of 6,000 square miles.

The principal tributaries that enter from the right bank of the river are the Snake River, which drains an area of 1,100 square miles, and the Kettle River, which drains an area of 936 square miles.

The tributaries from the south are the Yellow River, which drains an area of 360 square miles, and the Namekagon River, which drains an area of 908 square miles.

The river is made up of rapids and intermediate reaches of slight slope. At the rapids it flows generally over rock in place.

The average rain-fall is a little more than 30 inches, or over the whole area, 418,131,000,000 cubic feet. Owing to the area drained being for the most part wooded, the evaporation is probably a minimum, and it may be assumed that quite 40 per cent. of the rain-fall passes over Saint Croix Falls, which would give a mean flow per second for the year of 5,300 cubic feet; 4,000 cubic feet per second gives a good stage of navigation below the falls, and could this be made constant it would be of great benefit to the Saint Croix and the Mississippi River.

It is asserted by lumbermen that there are numbers of places where large reservoirs may be constructed, but only an instrumental examination can determine the matter.

The amount and character of the lands that would be submerged can only be determined after the sites for the reservoirs are chosen.

An examination to determine the practicability of creating reservoirs would cost as follows:

1 assistant engineer, 8 months, at $200	$1,600 00
7 laborers, 5 months, at $50	1,750 00
Subsistence, 5 months, at $105	525 00
Transportation, 5 months, at $100	500 00
	4,375 00
Add 10 per cent. for contingencies	437 50
	4,812 50

2.—CHIPPEWA RIVER.

The Chippewa River above Chippewa Falls drains an area of country of 5,600 square miles. It has many small tributaries. The only large one is Flambeau River, which enters from the east in township 33, range 7 west. At the headwaters of the Chippewa and Flambeau Rivers are many lakes, which are natural reservoirs, but as they are at the extreme headwaters they cannot be enlarged, as they do not drain each any sufficient area from which to collect water. There are several falls or rapids on these streams between which the rivers have very gentle slopes. The country is generally wooded, large bodies of pine woods are still standing. The lumbermen have built several dams on the river for storage of water for the purpose of driving logs at low stages down the river. These dams have been of great use to them, and they assert that there are many places where good reservoirs can be constructed.

It would be worth while to examine the two large tributaries of the Chippewa River that enter it below Chippewa Falls, the Menominee or Red Cedar from the west, and the Eau Claire from the east, the former draining 1,152 and the latter 864 square miles of land.

The Chippewa River is subject to great floods and very low stages of water, and it would be well worth while to examine the stream and its tributaries for the purpose of determining whether its flow cannot be governed.

The total area drained by the Chippewa River is about 8,000 square miles, and as there is at least a rainfall of 30 inches, there would be, supposing that but ¼ of the rainfall reached the mouth, a mean discharge of 5,900 cubic feet per second; 3,500 cubic feet per second will give an excellent stage of water on the Chippewa, and, if this flow could be maintained and the remainder could be stored up, it would do much to ameliorate navigation at extreme low water on the Mississippi River.

The practicability of constructing the reservoirs, and the amount and character, can only be determined by an examination of the river and its banks. The cost of such an examination would be about the same as above given for the Saint Croix River, or $4,812.

Very respectfully, your obedient servant,

F. U. FARQUHAR,
Major of Engineers.

Brig. Gen. A. A. HUMPHREYS,
Chief of Engineers, U. S. A.

APPENDIX C C.

REPORTS ON TRANSPORTATION-ROUTES TO THE SEA-BOARD.

C C 1.

SECOND SUBDIVISION OF THE MISSISSIPPI TRANSPORTATION-ROUTE.

PRELIMINARY REPORT OF MAJOR F. U. FARQUHAR, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Saint Paul, Minn., February 4, 1875.

GENERAL: I have the honor to make the following preliminary report of the results of an examination of the sites for reservoirs at the head-waters of the Mississippi River.

This examination was made by a party under the charge of Assistant J. D. Skinner, who, notwithstanding the shortness of the season and the great difficulties of the ground, by his intelligent working and energy, was enabled to gather all the necessary data called for by Congress, and leaves no doubt that large reservoirs may be constructed, which will retain the waters which prove often disastrous during freshets, and will furnish water at times when usually there is too little for navigation. It is to be regretted that no observations have been carried on to determine accurately the annual rain-fall in the region above, and discharge of the river at Pokegama Falls. The nearest post at which any continuous records of rain and snow fall have been kept is Fort Rip-

ley. It is believed, however, that the rain-fall above Pokegama Falls is in excess of that taken as the basis for the computations. The season was a favorable one for the survey, as there was an average low-water stage, and at no time, save a few days in October, was there any obstruction to navigation on the Mississippi River between Keokuk and Saint Paul. The steamboats made their trips without any great trouble.

The field-work consisted, 1st, in a tested line of levels, commencing at the mouth of Crow Wing River, running thence by road to Leech Lake, and thence to the other lakes, and down the Mississippi to place of commencement; 2d, meanders of the lakes and rivers, wherever the United States land surveys had not been made; 3d, careful gaugings of the rivers; and, 4th, a transit-line along the river, and detail survey of Pokegama Falls.

I.—DESCRIPTION OF COUNTRY AT HEADWATERS OF THE MISSISSIPPI RIVER.

The Mississippi has its sources near Lake Itasca, in Beltrami County, Minnesota.

From thence it flows northerly, and commences a great bend until it enters Cass Lake from the northwest, 135 miles* from Lake Itasca, in which distance it falls 172 feet.

The river runs through many small lakes, and its banks are generally wooded. Cass Lake is an irregular sheet of water, 1,318 feet above the sea, and has an area of thirty-one and six-tenths square miles. The banks are from 10 to 20 feet high. From Cass Lake to Winnibigoshish Lake the distance is about twenty miles, and the river falls 10 feet. Lake Winnibigoshish is a round sheet of water, surrounded generally by high banks covered with timber. It has a surface-area of seventy-eight and a half square miles. Just below its outlet the river flows between high banks only 1,000 feet apart—a very favorable location for a dam. About two miles below Winnibigoshish Lake the river widens out into Little Winnibigoshish Lake, which is about one and a half miles long and three-quarters of a mile broad. From Little Winnibigoshish to the junction with Leech Lake River, the river flows through a broad savanna from 1,000 to 5,000 feet wide, and is very tortuous. There are no obstructions to navigation, except four miles below the outlet of Little Winnibigoshish, where there are a few bowlders in the river between Winnibigoshish and Pokegama Fall. There is a fall 11.1 feet from the lake to the junction of Leech Lake River, a distance by river of twenty-five miles. From the junction to Pokegama Falls, a distance of forty-five miles, the river falls only 13¾ feet, and flows through high reeds and rice-fields in a most tortuous way. At White Oak Point the banks of the river separate to a width of more than two miles, and the space not filled by the current of the river is a vast reed-field. Leech Lake is an irregular sheet of water, with a surface-area of one hundred and ninety-five square miles. It lies just south of Cass and Winnibigoshish Lakes, and is separated from them by a ridge 30 feet high. Its outlet is the Leech Lake River, which connects it with the Mississippi.

The distance between Leech Lake and the Mississippi River is about thirty-five miles, and the fall 13.555 feet. The river is very tortuous, and flows back and forth between its banks through high reeds and rice-fields. About four miles above its mouth it widens out into a vast rice-field, called Mud Lake.

*See Nicollet's report, House Doc. 25, Twenty-eighth Congress, second session.

At Pokegama Falls the river falls over a ledge of sandstone. The stone is a metamorphic rock (quartzite), and seems well fitted for building purposes. The fall here is 14 feet in a distance of 880 feet. About three miles above Pokegama Falls is the outlet of Pokegama Lake.

The water-surface of this lake is only 2.6 feet above the water-surface just above Pokegama Falls. The lake has a surface-area of fifteen and two-thirds square miles. The banks are generally high, except at the southeast end and where the dividing ridge between it and the Mississippi River is only 8 feet above the lake. This low place is about one mile long, and the ridge is of sand. Any break through this ridge would be disastrous, as the fall is 30 feet to the Mississippi in only three miles' distance. Twenty-five miles above Pokegama Falls the Vermillion River enters from the south. Just below its mouth the banks of the Mississippi River are high and close together, and makes a good place for a dam. The whole country in the vicinity of the Mississippi River and the above-described lakes are densely wooded with Norway pine, on the highest ground, and a large amount of sugar and hard maples, birch, and poplar.

These ridges traverse great tamarack-swamps and quaking bogs. The soil is generally sandy, but clay here and there crops out in the banks, and undoubtedly underlies a great part of the basin.

II.—SITES FOR RESERVOIRS.

In considering the sites for reservoirs, I will commence at Pokegama Falls and consider the several available ones in their order, proceeding up stream.

1. *Pokegama Falls.*—The height to which a dam may be built at Pokegama Falls is regulated by that of the water-shed between its tributaries and the Mississippi below it. On examining the general map of the country (sheet 2 of the acccmpanying drawings), it will be seen that the lowness of the dividing ridge at the southeast end of Pokegama Lake will prevent any high dam from being built at Pokegama Falls.

Assistant Skinner reports that—

> Pokegama Lake has a surface-area of fifteen and two-thirds square miles. It is mostly surrounded by high land, from 25 to 150 feet in height, but at the southeast extremity of the eastern arm of the lake there is a depression of about one mile in length, which is but 8 feet above the level of the lake. It is the dividing ridge between the waters tributary to Pokegama Lake and those running eastward into the Mississippi, and is but 250 feet in width where the water-line of the lake would be if raised 6 feet. The small lake (marked *b* on sheet 2, accompanying tracing) is 6 feet above Pokegama Lake. There is no bank between it and the latter, which is distant from it about 500 feet. On the eastern bank of this lake the ridge spoken of rises 2 feet, continues at this elevation, or nearly so, for 250 feet, and then falls into a lake 800 feet wide and only 2¼ feet above Pokegama, and 3¼ feet below the small lake.
>
> The waters of this lake flow eastward into the Mississippi. The soil is loose and sandy, and there is no evidence of any rock in place near that locality. Immediately on the east side of the ridge are marshes, through which streams flow directly into the Mississippi at the point marked *c* on tracing.
>
> It would not be prudent, without a long dam on this ridge, extending to the high land on either side, to raise the lake more than 6 feet above its level of this autumn, as, in case of unusually high water, there may be risk of its finding its way across the ridge; and once started, it would soon wear away the loose soil, form a new river, and partially drain Pokegama Lake.

A dam raising the water at Pokegama Falls 7 feet would flow backwater over an area of twenty-three and sixty-one one-hundredths square miles, with an average depth of 5.7 feet.

2. The first place above Pokegama Falls at which it is practicable to dam the Mississippi for constructing a reservoir is just below the

mouth of the Vermillion River. Here the banks are from 15 to 20 feet high, and approach each other to a distance of 850 feet. A dam at this point raising the water about 10 feet would form a large reservoir, backing the water over the extensive marshes near White Oak Point, and into Ball-Club Lake. This would give a reservoir of about thirty-four and a half square miles with an average depth of 6 feet.

3. A dam just below Mud Lake, on the Leech Lake River, could be built that would raise the waters of Mud Lake 6 feet over a surface-area of seventeen and a fourth square miles.

4. *Leech Lake.*—This lake has a surface-area of one hundred and ninety-four and four-tenths square miles. Its outlet is very difficult to dam favorably or economically, 4,000 feet being the shortest distance between the high banks at any desirable point.

At the point marked *e*, a dam might be built that would raise the surface of the lake 6 feet were it necessary, but the scarcity of the supply for so large an area renders the raising of its surface more than 5 feet useless, as will afterward appear.

5. *Cass and Winnibigoshish Lakes.*—The latter lake has a surface-area of seventy-eight and a half square miles. It can be readily raised 10 feet above its ordinary level by a dam at its outlet. The fall from Cass Lake to this is 10 feet, so that the water would in fact be backed up into the former. No dam will be necessary at Lake Cass, as the lower lake can retain all its discharge. The location for a dam is favorable, the banks being high on either side, and not more than 1,000 feet apart.

Area of water-sheds of affluents of Mississippi River above the Falls of Saint Anthony.

Name of basins:	Area in square miles.
Mississippi River, above outlet of Winnibigoshish Lake	1,892
Leech Lake, above its outlet	1,001
Mississippi River, between Pokegama Falls and outlets of Leech and Winnibigoshish Lakes	772
Prairie River and left bank of the Mississippi River to Wild Swan River	365
Wild Swan River	477
Left bank of Mississippi River to mouth of Sandy Lake River	78
Right bank of Mississippi River from Pokegama Falls to Willow River	166
Sandy Lake	502
Left bank of Mississippi River and Rice River	360
Willow River	549
Right bank of Mississippi River to Pine River	154
Pine River	788
Right bank of Mississippi River to Crow Wing	144
Left bank to a point opposite mouth of Crow Wing River	481
Crow Wing River	3,562
Left bank of Mississippi River, opposite Crow Wing, to Fort Ripley	157
Left bank, opposite Fort Ripley, to Platte River	102
Platte River	401
Little Rock River, and left bank of Mississippi River, to Sauk Rapids	121
Little Elk, and right bank of Mississippi River, to Swan River	223
Swan River	162
Swan River to Sauk River	414
Sauk River	981
Right bank of Mississippi River, from Saint Cloud to Crow River, including Clearwater River	434
Left bank, from Sauk Rapids to Elk River	55
Elk River	630
Crow River	2,961
Rum River	1,542
Right bank of Mississippi River, from Crow River to Saint Anthony's Falls,	155
Coon and Rice Rivers	254
Total amount	19,903

III.—AMOUNT OF WATER TO BE RETAINED BY THE ABOVE-DESCRIBED RESERVOIRS.

The data for the calculation of the rain-fall are based on the average of the observed rain-fall for sixteen years, made at Fort Ripley. This average amount is 25 inches per year. The observed rain-fall and snow-fall for 1874 amounted to about 35 inches. From the gaugings of the Mississippi River at Sauk Rapids, and by means of comparison with the gauge at Saint Paul, it was ascertained that 41 per cent. of the computed rain-fall over the water-shed above Sauk Rapids was discharged at that point. In the absence of more extended observations, it may safely be assumed that there passes over Pokegama Falls at least 33 per cent. of the entire rain fall over the area above it. The reservoirs and their water-supply are as follows:

1. *Lake Winnibigoshish.*—This lake has a water shed of 52,746,019,920 square feet. One third of the rain-fall would give a volume of 36,629,-180,500 cubic feet. A dam would be required here not less than 14 feet high.

2. *Leech Lake.*—This lake has a total water-shed of 27,906,278,400 square feet. Taking 8⅓ inches as the depth of water that can be gathered in and discharged annually from this water-shed, we would have a supply of 19,379,359,983 cubic feet. This would require a dam of not less than 4 feet above the present level of the lake.

3. *Mud Lake.*—We have here a gathering-ground of 4,460,544,000 square feet, which would furnish 3,097,600,000 cubic feet of water. To hold this would require a dam at least 6 feet above the level of the lake.

4. *Vermillion River.*—Area of water-shed, 12,071,346,800 square feet; amount of available rain-fall, 8,382,879,722 cubic feet, which would require a dam at least 10 feet high.

5. *Pokegama Falls.*—Area of water-shed, 4,990,223,600 square feet; amount of available rain-fall, 3,465.433,052 cubic feet. Now the highest that the water can be raised at Pokegama Falls above the level of last October is 7 feet. This would create a reservoir of 3,886,290,794 cubic feet capacity. Total amount of water-shed above Pokegama Falls, 3,365 square miles; total assumed quantity of rain-fall available, 70,954,453,257 cubic feet.

The Sandy Lake, Pine River, Gull Lake, and Mille Lacs regions were also visited for the purpose of determining their values as holding-grounds for surplus water.

6. *Sandy Lake.*—Sandy Lake is a very irregular sheet of water, surrounded for the most part by sand-dunes. Its outlet is very broad, and would make the erection of a dam very costly, as the water would undoubtedly sweep through the sand-banks if the surface of the lake was raised. The Sandy Lake River, its outlet, is a very tortuous stream at low water. The high water is due to the high water of the Mississippi River, which backs the water up into Sandy Lake.

7. A good storage-ground for water was found on the Pine River. (See Detail Map No. 3.) Pine River runs through a series of connecting lakes. Just below Cross Lake there is a good place to build a dam. The water-shed above the outlet of Cross Lake has an area of five hundred and fifty-one square miles. Estimating the annual rain-fall at 25 inches, and that 8⅓ can be relied upon, there will result a total discharge per year of 10,752,698,880 cubic feet. The banks of the lakes are generally high, and have a surface-area of 491,301,043 square feet. If it were desirable to hold all the above water, it would require a dam 24

feet high, but from present information it would not be practicable to construct so high a dam. An additional dam at the mouth of Whitefish Lake might be constructed, 20 feet high, and the other at the outlet of Cross Lake, 12 feet high. The latter dam would create a reservoir of 4,913,000,000 cubic feet capacity, which, during the low-water season of the Mississippi River, August, September, and October, would furnish 630 cubic feet per second.

8. The system of lakes of which Gull Lake is the center (see Detail Map No. 2), and which discharge their waters into the Crow Wing River, through the Gull Lake River, form an excellent storage for water.

The discharge of Gull Lake River was, on the 10th of November last, 330 feet per second. The area of the water-shed of the Gull River above the outlet of Gull Lake is 7,582,924,800 square feet, and assuming that one-third of the annual rain-fall can be collected in the reservoirs and discharged therefrom, we would have 5,265,920,000 cubic feet. The area of Gull and adjacent lakes that can be used for storage purpose is 501,841,200 square feet, on which the water can be stored for an average depth of 10 feet, and 223,027,200 square feet, on which an average depth of 5 feet can be stored, giving a total capacity of 6,133,548,000 cubic feet. A dam 12 feet high can be easily constructed to obtain the above capacity of reservoir.

9. *Mille Lacs.*—This is a large lake, of one hundred and ninety-eight square miles in area. (See Detail Map No. 4.) It is the source of Rum River, which enters the Mississippi River at Anoka.

There is a good location for a dam at its outlet. Area of water-shed, 12,405,888,000 square feet; quantity of water, 8,684,121,600 cubic feet. Supposing that this whole amount could be stored, it would only raise the lake 1.3 feet.

The lumbermen have, from time to time, built temporary dams to aid them in getting a head of water which, when the dam was broken away, would carry their logs down the Rum River to the Mississippi.

There may be some points on the Prairie Deer Lake and Crow Wing Rivers that might be available for storing water.

To make a recapitulation of the above reservoirs:

Reservoir.	Area of water-shed.	Total water.
	Sq. miles.	*Cubic feet*
Winnibigoshish Lake	1,892	36,629,180,500
Leech Lake	1,001	19,379,359,963
Mud Lake	161	3,097,600,000
Vermillion River	432	8,382,879,722
Pokegama Falls	179	3,465,433,052
Total above Pokegama	3,665	70,934,453,257
Pine River	551	10,667,353,750
Gull Lake	272	5,265,920,000
Mille Lacs	444	8,684,121,600
Total	4,932	95,571,848,607

For purposes of navigation between Pokegama Falls and the mouth of the Prairie River there is required 2,474 cubic feet per second from May 1 to December 1, or for 214 days, which will require a reduction of the above amount of water by 45,743,270,400 cubic feet, leaving available for distribution at times of low water, 49,828,577,907 cubic feet.

Now there is a good stage of water on the Upper Mississippi River to

Saint Paul, when the amount of water passing Saint Paul is 12,000 cubic feet per second.

The extreme low-water flow of the Minnesota River is 800 feet per second. The low-water flow at the Falls of Saint Anthony during 1874, exclusive of the low-water flows from the country above described as gathering-grounds for reservoirs, was 26 per cent. of the mean flow due to the entire rain-fall. As this percentage would not change very much, we may compute the low-water flow at Saint Paul to 800 cubic feet + (26 per cent. of 27,547 *) +2,500 cubic feet to be uniformly discharged over Pokegama Falls=10,462 cubic feet per second. Now this low water never obtains before July 1, generally not before August 15; so, supposing that the low water continues from July 1 to December 1, or 153 days, it would only require a total of 20,331,129,600 cubic feet additional to be discharged from the reservoirs, not one-half of the above storage. The mean annual rain-fall, 25 inches, is, I think, quite small.

The following are the observed rain-falls at Fort Ripley for the past three years:

1871	34.02 inches.
1872	36 09 inches.
1873	40.78 inches.
1874, United States signal, Saint Paul	35.00 inches.

The reservoirs should be, if possible, large enough to hold two seasons' water, for should there be a succession of high-water years, they are likely to be followed by one or more low-water years, and then the reservoirs will come into play. Further explorations at the headwaters of the Prairie, Willow, and Crow Wing Rivers may develop good sites for storing water. The Pokegama Falls reservoirs may be supplemented by a dam at the outlet of Bass Lake, should a favorable site be found, and it is possible that a large reservoir can be created by damming the outlet of Deer Lake.

IV.—CHARACTER OF CONSTRUCTION FOR DAMS.

Except at Pokegama Falls, where a masonry-dam can be constructed, the proposed dams will be built of timber and earth. The conditions to be observed in their construction are, 1st, that the apertures at low water shall be equal to the low-water section of the river, so that the reservoirs can be drained as low as possible; 2d, that the dams shall be as high as the adjacent banks and dividing ridges between the proposed reservoirs and the river below will permit of; 3d, that where dams cannot be built high enough to retain more than the highest stage of water, a sufficient weir be made to make the dam safe; and, 4th, that the dams should be strong enough to resist any presumable pressure, and compact enough to prevent any possibility of percolation.

From the showing of clay in the river-banks, it is hoped that it may be found underlying the sites of the proposed dams. If it is, the mode of constructing the dams will be to drive two lines of sheet-piling the entire length of the dam, reaching down to the clay; after they are driven, to dredge out the material between them until the clay is reached, and then to fill up with a clay-puddle to the wood-work, and up to the top of the earth embankment, when one is used. The lower slopes of the embankments to be 1 to 1, and the upper, 2 to 1; the wood work to rest on a grillage which rests on piles. It will consist of a floor of 12 by 12 inch timber, resting on the grillage, and extending from above the piers

* Low-water flow for 25 inches of rain-fall.

to 20 feet below them. On this floor will be the piers, the intervals between them forming the sluices through which the water will be discharged. The piers will be built of 12 by 12 inch timber, and will be 6 by 12 feet at top; the upper slope being 1 to 1, with an angle on the upper face to break ice, and the sides and lower ends perpendicular. The piers will be filled with stone or earth. They will be placed 10 feet apart on the flooring, and well bolted to it. They will be connected with a crowning-piece, which will form the weir. Between the piers will be gates sliding up and down, which will be operated from a bridge supported by the piers.

There has been no time to work out all the details of these dams.

At Pokegama Falls it is proposed to put in a needle-dam, on the left chute, at the head of the falls, and a solid masonry-weir over the other. (See Detail Map.) By blasting out the head of the ledge, a greater aperture of discharge can be gained. Assistant Skinner reports the following estimates of the cost of the proposed dams, supposing them to be of timber:

Winnibigoshish Lake, 1,000 feet long	$59,969 80
Leech Lake, 4,000 feet long	177,555 64
Mud Lake, 600 feet long	31,737 20
Vermillion River, 850 feet long	56,245 20
Pine River, 592 feet long	32,386 20
Gull River, 442 feet long	25,786 20
Mille Lacs, 600 feet long	29,537 20
Pokegama Falls (masonry and needle-dam)	75,334 00
Total	488,551 40

I think that this estimate is large, and that further examination of the sites of the dams will materially diminish it. Of course, the selection of the sites could only be made after the maps were finished, and borings and minute surveys must still be made. The estimates for these surveys are contained in my letter of January 30; besides which some extended observations as to quantities of water falling and discharged should be made at and above Pokegama Falls.

This report is made hastily, the maps and computations having only been finished a few days. I forward by express, to-day, to your address, a package containing six tracings, showing the results of the last season's work, and one map showing the water-sheds of the several affluents of the Mississippi River above the Falls of Saint Anthony.

Very respectfully, your obedient servant,

F. U. FARQUHAR,
Major of Engineers.

Brig. Gen. A. A. HUMPHREYS,
Chief of Engineers, U. S. A.

CC 2.

PART OF THIRD SUBDIVISION MISSISSIPPI TRANSPORTATION-ROUTE.

REPORT OF MAJOR F. U. FARQUHAR, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Saint Paul, Minn., February 8, 1875.

GENERAL: I have the honor to make the following report of the results of an examination and survey of the Mississippi River, from

Pokegama Falls to the Falls of Saint Anthony, made with a view to determine the cost of improving the same, "so as to give from three to five feet navigation above the Falls of Saint Anthony, at the lowest stages of water." (See page 243, part 1st, Report 307, Senate Doc., 1st session 43d Congress.)

The three parties making the surveys were under the charge of Assistants J. D. Skinner, A. E. Stevens, and L. Y. Schermerhorn. The first-named making the examination between Pokegama Falls and mouth of Mud River; the second, a survey from mouth of Mud River to mouth of Sauk River; and the third, from mouth of Sauk River to the Falls of Saint Anthony. Want of funds prevented a survey above Mud River, but Assistant Skinner made special surveys at every obstruction reported by river-pilots. At the time (September 22 and 23) I passed over this part of the river, it was hard to recognize the so-called rapids, as there was a good stage of water over them, and the only steamer plying between Mud River and Grand Rapids made her trips without trouble until the close of navigation.

REPORT.

I.—DESCRIPTION OF RIVER FROM POKEGAMA FALLS TO FALLS OF SAINT ANTHONY.

The Mississippi River, below Pokegama Falls, has very different characteristics from those obtaining above. The banks are higher, marshes less frequent, and a true valley exists. The immediate valley is quite narrow, and bounded by hills until the flat region in which Sandy Lake is situated is reached. The river is confined within its banks, except at extreme high water. The bottom-lands between the valley's sides are covered with a dense growth of elm, ash, basswood, birch, and spruce, while the high lands generally bear white and Norway pines. The average fall of the river, from Pokegama Falls to Mud River, is about six inches per mile. The river is very crooked, and, as will be seen by the accompanying tracing, there are several places where the folds of the river approach very near each other. The most remarkable is where a portage of just 30 feet saves nearly three miles of canoe travel by the river. At one place, called the Cut-off, the river has but recently broken through, and the channel through the neck is quite deep and passable for steamboats. The lost channels are called by the river-men and Indians "logans" (lagoons). The banks of the river, whenever it impinges against the valley's sides, are of clay and gravel overlaid with sand or loam.

The principal tributary streams between Pokegama Falls and Mud River are the Prairie, Wild, Swan, Sandy Lake, Rice, and Mud Rivers, from the east, and Split Hand and Willow Rivers from the west.

Assistant Skinner reports the following obstructions to navigation between the foot of Pokegama Falls and mouth of Mud River, viz:

1. *Grand Rapids*, three and one-half miles below Pokegama Falls; here the river falls over a bowlder slope 5 feet in 1,750 feet; there is no rock in place. (See Detail Map No. 21 *u*.)
2. *Pine Rapids*, section 12, township 51, range 24 (see Detail Map. No. 21 *m*), gravel and bowlder bar; fall, 0.45 in 600 feet.
3. *Crooked Rapids*, section 22, township 51, range 24 (see Detail Map No. 21 *m*), gravel and bowlder bar; fall, 0.43 in 500 feet.
4. *Ox Portage Rapids*, section 2, township 50, range 24 (see Detail Map No. 21 *m*), a succession of gravel and bowlder reefs; fall, 0.6 in 290 feet.

5. *Sandy Lake Rapids*, section 24, township 50, range 24 (see Detail Map No. 21 *l*), bowlder reef; fall, 0.6 in 900 feet.

6. *Moose Rapids*, section 23, township 49, range 25 (see Detail Map No. 31 *l*), two bowlder reefs, 600 feet apart, extending from opposite banks of river; fall, 0.6 in 1,000 feet.

7. *Island Rapids*, section 15, township 48, range 26 (see Detail Map No. 21 *l*), wide, shallow river flowing over bottom covered with bowlders; very slight fall, only 0.44 feet in 1,586 feet.

8. *Large bowlders* in bed of river at places marked A, B, C, D on General Map No. 21, amounting to about 14 cubic yards in all.

9. As the river will very likely soon cut through at the point marked E on Tracing No. 21, Assistant Skinner recommends that a channel be dredged through it at once, to prevent the obstruction to navigation that will exist until the river-channel is entirely made through the neck.

10. *Snags.*—There are thirty-two snags to be removed between Grand Rapids and Mud Lake, and many overhanging trees.

From Rice River to sixteen miles below mouth of Mud River, the Mississippi is a sluggish and tortuous stream, flowing through low, marshy ground. The river has a good channel of more than 10 feet deep. The immediate banks are about 12 feet high, on which there is a thick growth of soft-wood trees, while the adjacent country, back from the river, is filled with small lakes, tamarack-swamps, and quaking-bogs.

The river is about 200 feet wide, with water slightly colored, and with a bottom of mud or sand. The fall of the river from Rice River to Pine Knoll is at the rate of 0.24 foot per mile. At Pine Knoll, sixteen miles below Mud River, the character of the river and country adjacent changes. The river becomes more rapid and wider. The sandy bluffs here appear from 20 to 60 feet in height, covered with a growth of small pines and bushes, the more valuable pine having been entirely cut off. A large portion of this country has been scourged with the annual fires. On the bluffs are seen a few granite bowlders.

From Pine Knoll* to Towhead Rapids,† the slope of the river for nine and one-half miles is ½ foot per mile. At Towhead Rapids the fall is, in 650 feet, 0.38 foot. From the foot of Towhead Rapids, for eleven miles, the slope is 0.86 foot per mile. Here the Pine River comes in from the north. The general course of the Mississippi has been from Mud River to this point almost due west. It now takes a sharp turn to south by east. The Pine River is a rapid stream, which discharged, at the low water of 1874, 782 cubic feet per second. It has a water-shed of seven hundred and eighty-eight square miles in area.

From the mouth of Pine River, for nine miles, to the head of Big Eddy Rapids, the average slope is 0.80 foot per mile. The adjacent country is much more broken, especially on the right bank. There are many springs issuing from the foot of the banks, which are strongly impregnated with iron. Big Eddy Rapids‡ occur in a straight part of the river. The right bank is 30 feet high, and the left bank 12 feet high; the river is narrow and deep; the slope is only 5.15 per mile for half a mile. Except for a few bowlders, there is a good channel over these rapids of at least 6 feet of water. At the foot of the rapids is the Big Eddy.‡ The river here widens to 730 feet, and the water is very shallow. One and a half miles below Big Eddy are Island Rapids‡ On these rapids the channel is only 3 feet deep for a distance of 3,000 feet. The slope, for the first 800 feet, is 4.62 per mile. At the foot of these rapids the Rabbit River comes in from the east.

* See Tracing No. 20. † See Tracing No. 19. ‡ See Tracing No. 18.

Six hundred and twenty-two miles below Island Rapids are French Rapids;* here the river is straight and narrow, flowing between high bluffs. The channel across them is from 6 to 10 feet deep. The slope for 1,000 feet is 7.4 feet per mile, and for 3,100 feet 5½ feet per mile. Below the rapids is shallow water. Three-fourths of a mile below French Rapids is French Bar,* where, for 500 feet, the slope is 10 feet per mile, and the river broad and shallow. Three and one-third miles below French Bar is Brainerd,† at which place the Northern Pacific Railroad crosses the river. The distance from Mud River to Brainerd by railroad is twenty-seven miles; by river, fifty-five and one-fourth. The elevation of the low water of 1874 at Brainerd was 1,169.60 feet above the sea. From above Brainerd to Crow Wing‡ the river is navigable at low-water, there being plenty of depth in the channel, and the slope being only 0.87 foot per mile. The river flows through high banks of sand covered with Norway, white, and jack pines; the country becomes more open as we leave Brainerd, some prairie approaching the river. Sixteen and a half miles below Brainerd the Crow Wing River enters from the west. It is the largest affluent of the Mississippi above the Falls of Saint Anthony; it drains a country of 3,562 square miles in extent. At the time of low water of 1874, its discharge per second was 2,699 cubic feet.

Just above the island, dividing it at its mouth, it was 250 feet wide. Its waters are very clear, and make a strong contrast with those of the Mississippi, and they do not fairly mingle for a distance of about four miles below their junction. The low-water discharge of 1874, of the Mississippi, three and three-fourths miles below the Crow Wing, was 7,099 cubic feet per second. From Crow Wing to Fort Ripley,§ nine miles, the river has a slope of 0.8 foot per mile. Fort Ripley is on a bluff 20 feet high on the right bank of the river, nearly opposite the Nokaysippi.

From Fort Ripley to Fort Anthony there is a notable difference in the amount of timber and height of bluffs on the two banks of the river, the west bank being the lowest, with the most timber, until we reach Sauk Rapids, while below Sauk Rapids the west bank is the highest as well as the most timbered. From Fort Ripley to Saint Cloud the river is a series of rapids, the intervening pools having also steep slopes. Two and a half miles below the fort is Olmsted's Bar. (See Tracing No. 14.) Here is seen rock in place for the first time below Pokegama Falls. The river is broad and shallow, with a slope of 4¾ feet per mile. The rock is a trap-dike, and extends 300 feet from the west bank into the stream. From the head of Olmsted's Bar, for four miles, the average slope is 4.14 feet per mile. In this distance there are fifteen islands, all heavily timbered, which are overflowed at high-water. Of the 4 miles there are one and one-fourth miles with less than three feet of water in the channel. Below the bar the water continues rapid, the average fall being 2.48 feet per mile. Nine miles below Fort Ripley (see Tracing No. 13 *k*) are Conradi's Shoals. Just above them, for a distance of two miles, the slope of the river is only 0.93 foot per mile. The bar is formed by the river widening out over a coarse gravel-bank, the depth of water in the channel being only two feet. The fall of the river in 1,500 feet is 4.74 feet, or 16.68 feet per mile. From this bar to Little Elk Rapids is 2.1 miles. (See Map No. 13 *k*.) Here the bed of the stream is rock in place. The river now fairly enters its passage across the outcrop of the great dike of crystalline rocks, its exit from which is just below Saint Cloud. By

*See Tracing No. 17. †See Tracing No. 16. ‡See Tracing No. 15. §See Tracing No. 14.

river this distance is sixty-one and one-fourth miles. Generally speaking, the rock does not show much above the water on either bank, being for the most part covered with drift.

Prof. David Dale Owen, on pages 165 and 167 of his report to the Commissioner of the General Land-Office of the results of his geological survey of Wisconsin, Iowa, and Minnesota, 1851, gives the following very interesting account of all the rocks crossed by the river between Saint Cloud and Fort Ripley:

> The rocks of this locality are of a character such as have yielded valuable ores in some regions of the Old World; but their elevation is but little above high water, and, except over limited tracts, they are entirely hidden from view by deep deposits of drift.
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> Seven to eight miles above Sauk Rapids, a short distance below Little Rock, is a higher exposure of crystalline rocks. A ridge of hornblende and syenitic greenstone, with veins of granite, bearing north 70° to 80° east, rises on the east side of the Mississippi to the height of 30 to 40 feet; and a short distance farther back even to the height of 60 to 70 feet.
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> About a mile and a half above Little Rock, a tough, close-grained hornblende rock appears on both sides of the Mississippi *in situ*, elevated from 2 to 4 feet above the water-level, and overlaid by sand and gravel; similar rocks appear at intervals between Little Rock and Knife Rapids (now called Pike Rapids). From the occurrence of superficial crusts, in pools of water collected in the hollows of these rocks, it is evident that oxide of iron enters largely into their composition, and exists in a state easily acted upon by the water.
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> Five or six miles above the mouth of Swan River, on the Mississippi, is an interesting exposure of gray-colored mica-slate, charged with large crystals of staurotide. The surfaces of the crystals are, however, rather rough, which impairs their beauty as cabinet specimens. This rock is exposed at intervals for three or four miles.
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> The mica-slate is succeeded still higher up on the Mississippi by magnesian slates associated with a tough, close-grained, hornblendic rock. The best exposure of these is on the rapids four miles above the mouth of Elk River of Nicollet, where they have a bearing of north 20° east, and in either nearly vertical or with a dip of 75° to 80° to the southwest. The slate has quartz-veins running through it. There is, however, but little opportunity to investigate its mineral character, for the banks of the river are quite low, only 12 to 15 feet above the water at the highest points, and 8 to 10 of this is soil and drifted materials.

This is the last locality where I observed any rock in place on the Upper Mississippi.

The fall at Elk Rapids is 7.2 feet in 5,100 feet. The steepest slope is 15⅓ feet per mile for a distance of 500 feet. From the foot of Elk Rapids to Little Falls, the slope for 1.8 miles is 3.17 feet per mile. This part of the river is filled with bowlders.

At Little Falls (see Tracing No. 13*k*) the stream is divided by Mill Island, and there is a fall of 5.03 feet in 1,800 feet; but there is one part in which the fall is 0.67 foot in 100 feet, and another in which the fall is 1.59 feet in 30 feet. The river runs over slate-rock, having a dip of 80° to the north, and a direction of north 80° east. On the right bank the rock rises above the water for half a mile, and is from 2 to 20 feet high. On Mill Island it is 15 feet above the water, and on the left bank it shows for 1,000 feet, but is only seen for 300 feet from the river.

From Little Falls to Pike Rapids, 4.7 miles, the river has an average slope of 3.40 feet per mile, the first three miles having a slope of 4.20 per mile.

At Pike Rapids (see Tracing No. 12*j*) the river flows over a bed of gray-colored mica-slate, which does not rise above the water on either bank. Here commences a series of rapid and rocky places extending for 6.7 miles, the average slope being 5.43 feet per mile, the maximum being 25.37 feet per mile for a distance of 350 feet at Pike Rapids.

Two miles below Pike Rapids is Cash's Bar (see Tracing 12*j*), where the river is only 2 feet deep, and flows over bowlders. Three thousand three hundred feet below Cash's Bar are Cash's Rips, where the river

flows over rock in place with a slope of $7\frac{1}{2}$ feet per mile. Then there is a slope of 4.01 feet per mile to McDougall's Rips. (See Tracings Nos. 11 and 12*i*.) One-fourth of a mile farther down stream are McDougall's Rips, where the river flows over rock in place with a slope of 17.42 feet per mile for 850.

The rock shows in both banks and rises above the water in the middle of the stream, forming a small island. (See Tracings Nos. 11 and 12*i*.)

Between McDougall's and Blanchard's Rips, a distance of 0.9 mile, the slope is 5.7 feet per mile, with a maximum of 12.16 feet per mile for 350 feet.

At Blanchard's Rips, the river falls over a rocky bed 1.80 feet in 1,356 feet. (See Tracings Nos. 11 and 12*i*.)

Between Blanchard's Rips and McDougall's Eddy, a distance of 1.7 miles, the slope is 3.97 feet per mile, with a good channel, except in one place. Below McDougall's Eddy there is good water for 20.8 miles, with an average slope of $1\frac{1}{2}$ feet per mile. In this distance the affluents of any importance are the Two Rivers and the Platte Rivers, both coming in from the east. The latter drains a water-shed of one hundred and ten square miles; it extends into the pine regions, and is much used by lumbermen. One and eight-tenths miles above the Little Rock Creek, rock in places appears. It is a tough, close-grained hornblende. Half a mile below the same creek, on the left bank, is a ridge of syenitic greenstone, rising 30 feet above the river.

The country on the left bank, between Little Rock and Watab, is very rough, being broken up by irregular mounds of greenstone with granite veins.

Watab Rapids (see Tracing No. 9) are formed by the river falling over a rocky bed two feet in 800 feet.

From the foot of the rapids to Sauk Rapids, a distance of four miles, the average slope is 2.51 feet per mile, with a maximum of 5.81 feet per mile for a distance of 1,525 feet.

The low-water discharge (1874) at just above the mouth of Sauk River was 9,202 cubic feet per second.

At Sauk Rapids (see Tracings Nos. 8 and 8*h*) the river, passing over a rocky bed, falls 17 feet in 4,000 feet. There is no well-defined channel for this distance. For nearly three miles the river-banks are, on both sides, 60 feet high, but grow lower just below Saint Cloud.

Assistant Schermerhorn makes the following report on the physical characteristics of the Mississippi between Sauk Rapids and the Falls of Saint Anthony: (See Tracings Nos. 1 to 8.)

The river-bed rests in an eroded valley, seldom exceeding one mile in breadth, and frequently reduced to a little more than the width of the river.

A cross-section of the valley generally shows a terraced bench from twenty to thirty feet above the river, intermediate in elevation between the river-banks and the table-lands. The river-bed inclines to the right of the valley center-line, making the western slope more precipitous than the eastern.

Bottom-lands are almost entirely wanting. Rock in place is found at Sauk Rapids, and forms the bed of the river for a distance of two thousand feet; disappearing from the surface it again rises over very limited areas—at the head of the so-called Thousand Islands.

The formation is syenitic granite of gray and gray-pink color. It is of even texture, and is used in the construction of the custom-house and post-office at Saint Paul.

Rock in place is next seen at a point three miles above the Falls of Saint Anthony, where it occurs as Saint Peter sandstone. Disappearing, it again crops out at the head of Nicollet Island with Trenton limestone superimposed. In this position it forms the bed and banks of the river at the Falls of Saint Anthony.

The river-banks are strongly defined, retaining floods entirely within their lines.

At a few points the river flows at the foot of loose sand and gravel slopes which rise from the water-surface to the table-lands. At such points the river slowly but continually encroaches upon the shore-line, producing an increasing width and decreasing

depth of river section. With these exceptions the banks are exceedingly stable, and carry an unchanging shore-line.

Islands are of frequent occurrence. In the upper part of the river they are found in groups of from three to five, but in the lower they are generally single and of increased area. They have originated from sand-bars and segregation from main-land. The former are seen in all stages of growth, but no indications were found of the latter in process of formation. Further confirmation of the not recent origin of islands from the main-lands is found in the difference of tree-growth, the islands being covered with elm, linden, and maple, the main-land with oak.

Cut-offs, except in a single case, were not found; hence the disturbance of the shore-line by the formation of chutes or cut-offs is not to be apprehended. The islands at times of freshets are submerged, but the dense trees and undergrowth protect them from erosion.

The river-bed, except in the vicinity of islands, is composed of very coarse drift varying in size from pebbles of a few inches to bowlders of several feet in diameter. Among islands the bed is generally sandy, or of less stable material than the undivided river. At rapids the bed is thickly covered with large bowlders. At several points the banks bordering rapids, although having ample slope and elevation to insure quick and efficient drainage, are yet impassable from ooze, indicating an impervious stratum near the surface. The presence of ferruginous stains along the banks, and the absence of rock in place, suggests a cemented agglomerate as forming the true bed at these points, and upon which the erosive action of the water has been less effective than upon the more yielding material below.

The diminished effect of this action over the harder areas would in time leave the river-bed elevated as it now is and producing the present rapids. As a whole, the river-bed possesses the requisites for great stability.

The low-water stage occurs near the last of October and is repeated with great regularity. The low-water stage referred to in this report is above the *extreme* low-water stage, but may be safely assumed to be below the *average* low-water stage of preceding years.

Average high water occurs between the months of June and August, during which the river rises from 5 to 7 feet above the low-water stage.

On July 16, 1864, the river rose to an elevation of 14½ feet above low stage; this was an exceptional freshet, and is referred to as the highest known water. The breaking up of the ice in the spring is not accompanied with unusually high water, and generally occurs between the first and middle of April. The river closes between the first and last of December, giving a navigable season of about two hundred and forty days.

The exemption of the river from cut-offs, the absence of low bottom-lands, the strong confinement within its natural banks, the stable character of the material forming its bed, and the absence of silt, seem to furnish the requisites for a condition of great stability as regards its width, position of shore-line, and channel, enabling constructions and work to be planned with a degree of confidence not otherwise possible.

The following are the obstructions to navigation between Sauk Rapids and the Falls of Saint Anthony. At the Thousand Islands (see Tracing No. 8) the river is divided into several channels. The right-hand one has been chosen as the one to be improved, and the wing-dams shown on the tracing were built in 1874. The only further improvement here is to close the left channel at the head of the islands. Just below the Thousand Islands are the Mosquito Rapids, where the slope is excessive, and the depth of water insufficient. (See Tracing No. 8.)

The bed of the river is covered with bowlders. Twenty-two and one-half miles below Mosquito Rapids are Smiler's Rapids. (See Tracing No. 6*f*.) The river falls here 2.1 feet in 1,160 feet, producing a very rapid current and shoal water. There is a rock in the channel just above these rapids, known as Smiler's Rock, which is very troublesome to river men.

Six miles below Smiler's Rapids are Cedar Island Rapids (see Tracing No. 5*e*), where the river widens out and becomes shallow. The river has a slope of 4.26 feet per mile, but this can be reduced, and the depth of water increased, by closing up the wide channel and using the right channel, thus gaining a distance of 2,000 feet.

Six miles below Cedar Island Rapids are Battle Rapids. (See Tracing No. 5*d*.) Here the river runs over a bowlder-reef, and falls 2.3 feet in 1,800 feet. Except Coon Rapids, this is the most dreaded of all obstructions to navigation between Saint Cloud and the Falls of Saint Anthony.

Houghton Flats (see Tracings Nos. 4 and 5*c*), two miles below Battle Rapids, is a shallow reach of the river, caused by its spreading out, and its slope of 5.11 feet per mile for one and one-third miles. Spring Rapids, one and three-tenths miles farther down, are caused by the river running over a bowlder-reef, and falling $1\frac{1}{2}$ feet in 800 feet. The deep pool above will admit of the dredging of the crest of the bowlder-reef, and the consequent reduction of the slope.

Dayton Rapids (see Tracing No. 3), twelve miles below Spring Rapids, are caused by a bowlder-bar, the removal of a part of which would do away with all trouble to navigation.

Anoka Rapids (see Tracing No. 2) are the next obstruction. They occur ten miles below Dayton Rapids, and are caused by bowlders in the channel, which can be removed by dredging.

Coon Rapids (see Tracing No. 2*b*) are two and one-half miles below Anoka Rapids, and are the worst obstruction to navigation between the Falls of Saint Anthony and Sauk Rapids. The bed of the river is thickly covered with bowlders, the worst of which were removed in 1874, and the river falls 6.9 feet in 3,600 feet. The river widens from 675 feet above the rapids to 900 feet below. A long, deep pool above these rapids admits of dredging through the crest of them to reduce the excessive slope.

Fridley's Bar (see Tracing No. 1*a*), five miles above the Falls of Saint Anthony, is caused by the excessive widening of the river. The above are the principal natural obstructions to navigation on this part of the river. There are, however, many slight obstructions, which are shown on the tracings and which must be removed. They generally consist of sand-bars in wide portions of the river, and a judicious use of wing-dams it is thought will serve to correct the trouble. In many places the river is eroding the high banks of sand and gravel and carrying the materials into the river to form bars. In all such cases the banks must be protected.

The artificial obstructions consist of bridges, boom-piers, and running logs. The following are the bridges:

Hennepin avenue, Minneapolis, lower chord 22 feet above low water.
Saint Paul and Pacific Railroad, 23 feet above low water.
Fourth avenue, 15.5 feet above low water.
Saint Paul and Pacific Railroad, Saint Cloud, 35 feet above low water.
Road bridge, 40 feet above low water.

The Minneapolis Boom Company have, in order to carry on their business of receiving, sorting, and storing logs, constructed many boom-piers just above the railroad bridge at Minneapolis, and use the large area of the river afforded for some miles above as booming-grounds. At times they occupy the whole water-way for more than a mile above said bridge. By an inspection of the accompanying tracing it will be readily seen what an obstruction these boom-piers are to navigation, not only just above Minneapolis, but at Anoka, Elk River, Monticello, Clearwater, and Saint Cloud. Where islands are in the river, one of the channels is used as booming-grounds, boom-piers being built at the lower ends of the islands.

In improving the river it may be necessary to close or to use these side-chutes, and thus the value of the booming-grounds will be destroyed, and the rights, real or assumed, of the parties using the booms be interfered with.

The danger to steamboats by reason of the running of saw-logs down the Mississippi, with no other guidance than the current of the river, is very great. The magnitude of this obstruction may be appreciated when it is considered that 225,000,000 feet, board-measure, of logs were

so floated down to Minneapolis during 1874, besides a large unknown quantity floated to mills at Anoka, and above.

If the government is to improve this great water-way, it must certainly prevent these moving obstructions, that no skill of the pilot can avoid.

II.—IMPROVEMENTS NECESSARY TO OVERCOME THE ABOVE-DESCRIBED OBSTRUCTIONS.

The following is the list of improvements, together with quantities of wing-dams and dredging necessary for a channel 200 feet wide and 5 and 3 feet deep, with no slope greater than 5 feet per mile:

Between the Falls of Saint Anthony and Saint Cloud.

Distance from Saint Anthony.	Character and location of obstruction.	For five feet depth.		For three feet depth.	
		Dams.	Dredging	Dams.	Dredging.
Miles.		*Lin. ft.*	*Cubic yds.*	*Lin. ft.*	*Cubic yds.*
76.5	Bowlder-bars		25,000		
75.5	......do	110			
75.7	......do	115			
74.4	Sand-bars (island)	460		300	
71.5	Rapids (Mosquito)	250	10,000		10,000
71.2	Sand-bars (island)	160			
70.8	......do	280			
70.5	......do	100			
70.0	Sand-bars	200			
69.8	....do	200			
68.0	Gravel-bar	120			
66.6	Sand-bar (island)	1,066			
58.8	Sand (Big Bend)	600			
53.0	Rapids (Smiler's)		50,000		40,000
52.7	Sand-bar (island)	470			
51.5	Gravel-bar		2,000		
49.5	......do	260			
47.4	Gravel-bar (Cedar Rapids)	800	10,000	400	
46.0	Sand-bar (island)	380			
45.5	Gravel-bar	615			
44.4	Sand-bar (Monticello Creek)	175			
43.4	Sand-bar (island)	220			
42.4	Bowlder-bar	150			
41.4	Rapids (Battle)	81	35,000	81	30,000
40.3	Bowlder-bar	320		150	
39.0	Sand-bar (Houghton Flats)	930		700	
38.4	Gravel-bar	250			
37.7	Rapids (Spring)	100	15,000	100	10,000
36.6	Sand-bar (island)	450			
35.6	Bowlder-bar	570			
34.8	Sand-bar (island)	400			
33.3	..... do	400			
32.5	.... do	500		500	
31.0	Sand-bar	300			
29.5	Gravel-bar	100			
27.8	Bowlder-bar		5,000		
26.7	Bowlder and sand (island)	875			
25.8	Rapids (Dayton)		3,000		3,000
25.0	Sand-bar (island)	510			
24.3	Gravel and sand	550		275	
20.6	Sand-bar	170			
20.0	.....do	180			
17.0	Rapids and bar (Anoka)	540	2,000		1,000
16.0	Gravel-bar	460			
13.0	Rapids (Coon)		50,000		40,000
12.2	Gravel-bar (island)	1,000			
9.5	Gravel-bar	140			
4.8	Bar (Fridley's)	850		850	
	Total	16,467	207,000	3,356	134 000

2. To overcome the obstructions to navigation between the foot of Sauk Rapids to the head of Conradi's Shoals, recourse will have to be made to locks and dams and to some little dredging. Only approximate

estimates are presented for this work, as exact surveys will have to be made of the sites for the proposed dams. For these surveys an estimate was forwarded in my letter of January 30, 1875.

By examining Tracing No. 8*g*, it will be seen that the plan proposed to pass boats over Sauk Rapids is to build a masonry-dam over that part of the river not already dammed at Sauk Rapids, and to make a canal in the upper level along the west bank down as far as the old steamboat-landing at Saint Cloud. At the lower end of the canal a lock with a chamber 50′×200′ and 17 feet lift is to be constructed; the canal to have a least width of 100 feet at the water-line, and a least depth of 5 feet, and to be 5,000 feet long, the entrance to the canal to be protected by guard-gates.

This improvement will cost as follows:

If the lock-chamber sides are of hammered masonry, backed with rubble-masonry, iron gates, and crib-dam	$647,000
Ditto. Concrete in place of rubble-masonry	520,000
Ditto. Concrete sidewalks protected with wooden fenders, except in hollow quoins and gate-recesses, where dressed stone will be used	464,000

Between the head of Sauk Rapids and McDougall's Eddy there are some rock and bowlders to be removed and some wing-dams built, viz:

Distance from Saint Anthony.	Location.	Wing-dams. For five feet depth.	Wing-dams. For three feet depth.	Bowlders.
Miles.		*Cub. yds.*	*Cub yds.*	*Cub. yds.*
	Watab to Island 100, 31 bowlders			414.4
	Left bank to Island 100	600		
	One-half mile above Island 100	1,050		
	Watab Rapids	345		
83	At Watab	840		
	Right bank to Island 93	525		
	One-fourth mile above Pike River	625		
	Left bank to Island 89	360		
	Island 88 to 89	460		
	Left bank to Island 83	390		
	Left bank to Island 79	500		
	One-half mile below McDougall's Eddy	360		
	From upper end of Island 78	600		
	Right bank to Island 78	100		
102	One-fourth mile below McDougall's Eddy	810		
	Total	7,495		414.4

Between McDougall's Eddy and the top of Conradi's Shoals three locks and dams will be necessary: One located at Blanchard's Rips, (see Tracings Nos. 12 and 11 and 12*g*), with a lift of 10 feet; one at Cash's Island (see Tracings Nos. 12 and 12*i*), with a lift of 13 feet; and the third at Little Falls (see Tracings Nos. 13 and 13*j*), with a lift of 22 feet. These locks will have chambers of 50′×200′. The dams will be of timber.

The approximate estimates for these, supposing them to have timber bottoms and side and lift walls of concrete, will be as follows:

Blanchard's Rips	$332,352
Cash's Island	446,430
Little Falls	695,127

The estimates are only approximate, as detailed surveys of their sites will have to be made before the exact quantities of excavation and embankment can be obtained.

This survey will also determine the exact lines on which the dams are built.

Besides the locks and dams in the above interval, the following improvements will be necessary:

Distance from Saint Anthony.	Location.	Wing-dams.		Bowlders.
		For five feet depth.	For three feet depth.	
Miles.		*Cub. yds.*	*Cub. yds.*	*Cub. yds.*
	Left bank to Island 77	950		
	From right bank opposite Island 63		860	
	Left bank to Island 62	1,740		
	Right bank to Island 61	450		
	Left bank to Island 60	480		
	At mouth of Pike Creek	380		
	From Island 59	375		
	Left bank to Island 59	300		
	Three-quarters of a mile below Little Falls			11.6
114.15	One-quarter of a mile below Little Falls	325		
	Total	5,000	860	11.6

3. From above Conradi's Shoals to the foot of Grand Rapids (see Maps Nos. 9 to 21) the improvements will consist of dredging and wing-dams or jetties.

The following is a list of obstructions in this section of the river, together with the quantities and kinds of materials to be removed and placed at each obstruction:

Distance from Saint Anthony.	Location.	Wing-dams.		Bowlders.
		For five feet depth.	For three feet depth.	
Miles.		*Cub. yds.*	*Cub. yds.*	*Cub. yds.*
	One-half a mile below Island 42	450		
	From Island 42	300		
	Left bank to Island 41	650		
	Island 42 to 41	525		
	One-half a mile below Big Bend	1,100		
	Three-quarters of a mile below Olmsted Bar		370	
129.1	Olmsted Bar			2.6
	......do		5,195	
	......do	4,615		
	One-half a mile above Nokay-sippi	495		
	64.7 miles from Aitken			11.8
	58.9 miles (3 6 below ——)	900		
	53.2 miles from Aitken	400		
154.7	French's Bar		1,490	
	Foot French Rapids	645		
	Island No. 7 to left bank	630		
163.2	Island Rapids	2,225		
164.7	Foot Big Eddy Rapids	330		
	37.3 miles from Aitken	300		
	37.2 miles from Aitken	150		
	36.4 miles from Aitken	225		
	One-half a mile below Pine River			6.1
172.3	At mouth Pine River	500		
	Three-quarters of a mile below Pine River	175		
181.3	Tow-head Rapids	275		
	Total to Mud River	14,870	7,055	20.5

List of obstructions, &c., from Mud River to foot of Grand Rapids.

Distance from Saint Anthony.	Location.	5 feet depth.			3 feet depth.			Bowlders.
		Wing-dams.	Dredging.		Wing-dams.	Dredging.		
			Sand and clay.	Bowlders.		Sand and clay.	Bowlders.	To be blasted.
Miles.		*Cub. yds.*	*Cub. yds.*	*Cub. yds.*	*Cub. yds.*	*Cub. yds.*	*Cub. yds.*	*Cub. yds.*
236.7	Island Rapids	225	9, 215	9, 215	225			10
	D (Tracing No. —)							3
238	Moose Rapids			3, 703			1, 234	15
	C (Tracing No. —)							4
253	Sandy Lake			4, 444				20
	B (Tracing No. —)							3
	A (Tracing No. —)							4
267.5	Ox Portage Rapids	150	4, 213	4, 213				25
273	Crooked Rapids			2, 962				30
284	Pine Rapids			6, 666				25
292	Cut-offs to be excavated	2, 692						
	Total	3, 067	13, 428	31, 303	225		1, 234	139

Grand Rapids is three hundred and fifty-seven miles above the Falls of Saint Anthony. To extend navigation from the foot of Grand Rapids to the foot of Pokegama Falls, three and a half miles, a lock will be required.

The total fall from the top of Pokegama Falls to the foot of Grand Rapids is 21¾ feet.

It is proposed to build a dam on Pokegama Falls to raise the water there 7 feet, so that to pass from the foot of Grand Rapids to above the falls will require a lockage of 28¾ feet, 9 feet of which would be made at Grand Rapids and 19¾ at Pokegama Falls. No estimates are submitted with this report, as there are not sufficient data for the purpose.

Above Pokegama Falls the navigation is unobstructed to Cass Lake, save a few bowlders below the outlet of Little Winnibigoshish Lake. Above Cass Lake the river is a series of rapids, with lakes between them, and any improvements will consist of locks and dams.

RÉSUMÉ OF PROBABLE COST OF IMPROVING THE MISSISSIPPI RIVER FROM THE FALLS OF SAINT ANTHONY TO GRAND RAPIDS, 357 MILES, SO "AS TO GIVE 5 FEET NAVIGATION AT LOWEST STAGES OF WATER."

1. *From Falls of Saint Anthony to Saint Cloud:*

32,934 cubic yards brush wing-dams, at $1.25	$41, 167 50	
207,000 cubic yards dredging, at 50 cents	103, 500 00	
Total		$144, 667 50

2. *From Saint Cloud to Conradi's Shoals:*

Lock and dam at Sauk Rapids	$464, 000 00	
Lock and dam at Blanchard's Rips	332, 352 00	
Lock and dam at Cash's Island	446, 430 00	
Lock and dam at Little Falls	695, 127 00	
12,495 cubic yards brush wing-dams, at $1.25	15, 618 75	
425.6 cubic yards bowlders, at $10	4, 256 00	
Total		1, 957, 783 75

3. *From Conradi's Shoals to Grand Rapids:*

17,397 cubic yards brush wing-dams, at $1.25	$22, 421 25
13,428 cubic yards dredging, sand and clay, at 50 cents	6, 714 00

31,203 cubic yards dredging, small bowlders and gravel, at 75 cents	23,402 25	
159 cubic yards bowlders to be blasted out, at $10	1,590 00	
Total		54,12
Total cost for a channel 5 feet deep		2,156,57

FOR A CHANNEL 3 FEET IN DEPTH.

1. *From Saint Anthony to Saint Cloud:*

6,712 cubic yards brush wing-dams, at $1.25	$8,390 00	
134,000 cubic yards dredging, at 50 cents	67,000 00	
Total		75,39

2. *From Saint Cloud to Conradi's Shoals:*

Lock and dam at Sauk Rapids	$464,000 00	
Lock and dam at Blanchard's Rips	332,352 00	
Lock and dam at Cash's Island	446,430 00	
Lock and dam at Little Falls	695,127 00	
836 cubic yards brush and wing-dams, at $1.25	1,045 00	
425.6 cubic yards bowlders to be blasted, at $10	4,256 00	
Total		1,943,21

3. *From Conradi's Shoals to Grand Rapids:*

7,280 cubic yards brush wing-dams, at $1.25	$9,100 00	
1,234 cubic yards bowlders and gravel, at 75 cents	925 50	
159½ cubic yards bowlders to be blasted, at $10	1,595 00	
Total		11,62
Total cost for a channel 3 feet deep		2,030,22

The question of the cost of improving navigation above Gr Rapids can only be answered after Congress has determined whet the reservoirs recommended by the Senate Select Committee on Ch Transportation-Routes are to be constructed.

III.—COMMERCE TO BE SERVED BY THE ABOVE IMPROVEMENTS

For these statistics I would respectfully refer to the Report of Senate Select Committee on Cheap Transportation-Routes to the S board. (Report 307, 1st sess. 43d Congress.)

In closing this report, I would state that it is only preliminary t more complete one to be rendered when the detailed surveys of the si of proposed locks and dams have been made.

Great credit is due to Assistants J. D. Skinner, H. E. Stevens, and Y. Schermerhorn for the able manner in which they performed th work, and the economy they exercised.

The general maps are numbered consecutively from 1 to 21, and on a scale of $\frac{1}{4800}$; the detailed maps of obstructions are lettered they go up stream with the number of the general map on which obstruction is found prefixed; thus, 21*k* refers to detail-sheet *k*, and general sheet 21. The scales of the detail-maps are expressed up them.

I forward this day, by express, a package containing the above t cings, thirty-three in number.

Very respectfully, your obedient servant,

F. U. FARQUHAR,
Major of Engineers

Brig. Gen. A. A. HUMPHREYS,
Chief of Engineers U. S. A.

CC 3.

PART OF THE THIRD SUBDIVISION OF THE MISSISSIPPI ROUTE, WHICH COMPRISES THE IMPROVEMENT NECESSARY TO GIVE A NAVIGATION OF 4½ TO 6 FEET FROM FALLS OF SAINT ANTHONY TO SAINT LOUIS.

REPORT OF COL. J. N. MACOMB, CORPS OF ENGINEERS.

By letter from the Chief of Engineers, United States Army, dated 29th June, 1874, I was assigned to the duty of making two of the surveys under the above head, viz, that for the improvement of that portion of the Mississippi route designated as "Improvement upon a system to be provided so as to give from 4½ to 6 feet navigation at lowest stages from Falls of Saint Anthony to Alton" (afterward modified so as to make Grafton, Ill., the southerly limit); and the survey of so much of the northern route as is designated "the Hennepin Canal, from some point on the Mississippi River near Rock Island to the Illinois River at Hennepin."

For this latter survey I employed Mr. F. C. Doran, who organized a party and took the field in August, 1874. His report was sent in on 25th January, 1875, and the maps to illustrate the same were forwarded on 13th April, 1875. This report sets forth the feasibility of making an improvement by which the Upper Mississippi River, near Rock Island, could be connected with Lake Michigan at Chicago, via Hennepin, so as to pass barges which are used for freight on the Upper Mississippi River. But to make the connection complete, it involved a costly improvement of the Upper Illinois River and Illinois and Michigan Canal. No money having been granted for this work, the party was gradually reduced, and, after closing the records for the files of my office, the chief of the party was discharged on the 10th May, 1875.

The survey of the Mississippi route was intrusted by me to Mr. Montgomery Meigs, who was employed as assistant engineer, and organized a party and took the field in the latter part of August, 1874. His preliminary report was sent in on 12th January, 1875; and, as I had minute surveys in my possession incidental to the improvements in progress under my charge at Rock Island or Upper Rapids, and at Des Moines or Lower Rapids of the Mississippi River, I sent in, on 11th January, 1875, and on 26th January, 1875, reports touching the expense of making any change in these costly improvements which are now nearly completed, and the plans of which are deemed perfectly satisfactory to those concerned in the navigation of the river. I beg leave to refer to the above-named reports, and to ask that they may be accepted as a part of this my annual report.

I have the honor also to submit the report of Assistant Meigs upon the survey of the Upper Mississippi River, as far as the party were enabled to prosecute the work, viz, from Saint Paul, Minn., to La Crosse, Wis., by which it will be seen that he estimates the cost of improving that portion of the river so as to afford a depth of 4½ feet at low water to be $348,670, and suggests that $100,000 should be asked for to defray the expenses of the first year's operations, which should be undertaken at certain difficult points named between Saint Paul and Winona, Minn.

It is proposed, with the funds remaining in hand, to push the surveys on the Mississippi River as far down as possible, in order to the preparing of estimates for improving that part of the river between La Crosse and mouth of the Illinois River.

Financial statement.

Amount allotted for surveys, &c., intrusted to me........................	$30,0
Amount expended for Hennepin Canal on northern route survey..........	9,6
Amount expended for survey of Mississippi route	16,3
Remaining on hand 1st July, 1875, which will be applied to continuing survey of Mississippi route..	4,0
Amount required for fiscal year ending 30th June, 1877, to be applied in commencing the improvement of the Upper Mississippi River, in accordance with the scheme indicated in the report of the survey.............	100,0

REPORT OF MR. MONTGOMERY MEIGS, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., May 31, 1

SIR: I have the honor to present my report on the above-named route, together plans and estimates for the improvement of the river down to the vicinity of La C Wis., which is as far as our survey was carried last season.

The data upon which such plans are based are General Warren's maps of the from his surveys of 1866 to 1869, and the resurveys of detached difficult portions river made last season under your directions.

General Warren's maps, tracings of which were sent to this office from Washin are as follows:

Map of the Mississippi River, in 22 sheets, from mouth of the Minnesota Riv mouth of the Ohio. Surveys, 1866–'69; scale 2 inches to the mile; compiled from U States land survey, General Warren's survey, and existing authorities.

Mississippi River: Separate maps of important localities, viz:

Falls of Saint Anthony to Outlet Lake, Saint Croix, 10 sheets, Nos. 1–10, 1866–'
No. 11. Mouth of Cannon River.
No. 12. Channels at Head of Lake Pepin.
No. 13–16. Lake Pepin to Winona.
No. 17. Trempe à l'Eau.
No. 18. Mouth of Black River.
No. 19. La Crosse.
No. 20. Brownsville, Minn., to Bad Axe, Wis.
Nos. 13′ and 16′. Resurveys, at different times.
No. 21. Vicinity of Lansing.
No. 22. Prairie du Chien.
No. 23. Guttenberg.
Nos. 24 and 24′. Dubuque.
No. 25. Vicinity of Clinton.
No. 26. Vicinity of Rock Island.
No. 27. Vicinity of Burlington.
No. 28. Vicinity of Keokuk.
No. 29. Vicinity of Quincy.
No. 30. Vicinity of Hannibal.

Mississippi River, in the vicinity of Fort Snelling, Minn., showing remarkable ch by the flood of 1867.

These maps, made under the direction of General G. K. Warren, in 1866–'69, and prising all the information to be had at Headquarters, Engineer Department, in W ington, were forwarded to Rock Island, and placed at your disposal. They conta the information concerning reference-points, bench-marks, &c., which would be u in a resurvey.

On July 27, the construction of the quarter-boat for use of the surveying part well under way. Her hull was finished, but her cabin, equipment, &c., were sti complete, and it was not until August 27 that all was in readiness to proceed u river and begin operations.

While the building of the quarter-boat was in progress the details of our plan of ations were studied. General Warren's survey having been made so long ago, an river having since then changed its channel, at some places many times, the soun were deemed unreliable for the purpose of making plans and estimates for imp ment, and some resurveys considered indispensable. In view of the small amou time at our disposal, and the fact that a good general map had already been ma nearly all the points offering important difficulties to navigation, it was thought to make use of the old maps as much as possible, and only survey such lines as w be necessary for making accurate soundings.

General Warren's survey was made with compass (see General Warren's report, 1

letter of General A. A. Humphreys, January 29, 1867, page 8 of report), but it was thought best to substitute the transit or theodolite for the compass in our work, and to locate the soundings in wide reaches of the river with angular measurements from bases on shore, in order that the work might be more accurately referred for comparison in case at any time the study of the river should necessitate resurveys.

It was found almost invariably that the reference-points indicated on General Warren's maps had disappeared. In some cases the trees on which bench-marks had been cut were found to have been disturbed, either by the felling of the tree or caving in of the bank, but in most cases no benches or reference points could be found, and the absence of such marks was the more annoying, as it made difficult, if not impossible, the comparison of the surveys as to stage of water and location.

From Captain Davis, of the Montana (a river expert), a list of places was obtained where, in low water, steamboats usually had difficulty; and it was thought best, in view of the object for which the survey was undertaken, to restrict the new surveys to those places, and to endeavor to leave such marks on each detached work as would serve to establish at least a few of its most important points.

The rapid changes, which are of continual occurrence in the channel and banks of the Upper Mississippi, form an interesting engineering study. The causes leading to such changes are so obscure, and often, no doubt, so purely accidental, that our only hope of ever arriving at a knowledge of them will be to make surveys that can be easily reproduced at any future time, and from time to time repeat the work. The value of the surveys will be in direct proportion to the manner in which these points have been "referred."

It was impossible in most cases, with the means at hand during our survey of last year, to do more than mark trees at a safe distance from the bank to serve as references.

Some less perishable monuments should be erected to take the place of these. The best plan would be to triangulate the bluffs of the river, and locate everything from them.

This has been already advocated by yourself and General Simpson and others well acquainted with the unstable condition of the bed of the Mississippi River; but for the present stone blocks would be of small expense, and would serve to preserve the work already done.

ORGANIZATION OF PARTY.

The surveying party consisted of 1 chief assistant engineer, 3 assistants, 1 rodman, 1 boat-steerer and recorder, 2 boatmen, 2 recorders of angles, 1 signalman, 2 chainmen, 5 axmen, 1 cook, 1 assistant cook—total 20 men.

The plan of making the men manage their own subsistence department worked well. I think all were satisfied, and the expense per man was but $13 and a fraction per month. Our plan of operations was for one assistant and party to lay out the bases for the sounding-party and cut out the line, and while the latter was engaged on the bases, the same assistant went back and ran the levels of each survey.

I had not men enough to run a continuous line of levels, and shall, if possible, connect the separate lines during the present season. As we started at Saint Paul, we had the advantage of moving with the current, and found no difficulty in managing the quarter-boat, except in high winds, when the large surface exposed by her cabin made her unmanageable. I think, however, that we lost in all less than one day's work from this cause, and would have found a steamer, unless it had been a very light-draught steam-launch, an expensive and almost useless adjunct.

Since the completion of our field-work we have been engaged continuously in reducing and plotting the notes. In the maps I have made the most extensive use of General Warren's surveys, which, I will add, we found remarkably reliable, except the soundings. The lines run by my party and the triangulations are all indicated on my maps; transit and theodolite lines in full black lines, compass lines in red. The rest of the work, where no surveyed lines are given, is taken from General Warren's survey. All the located soundings were plotted on a scale of 100 feet to the inch, and transferred to the finished map on a scale of 200 feet to the inch. The reduction and transfer were performed by means of a system of squares, brass frames with very fine steel cross-wires being laid on the drawings, and corresponding squares filled up in succession with the soundings. As many as 2,500 soundings have been in this way transferred to the map by two men during office-hours of one day. The original plotting proceeded at the rate of about 500 a day for two men.

THE MISSISSIPPI RIVER.

Quite a full description of the Upper Mississippi has already been written by General Warren, and presented in his report of 1867.

It will be unnecessary for me to do more than allude to the nature of the stream already well described. From Saint Paul to La Crosse its course is winding, flowing almost invariably over a sandy bottom, which changes its shape after every rise, and at low

water presents serious, and sometimes impassable, obstacles to navigation. At age low water 3 feet is about the depth on the bars; and as most of the large s ers, and even the small ones, draw 3 feet 6 inches to 4 feet 6 inches, or 5 feet lo they are stopped at the bars and obliged either to spar over, or, when that is im ble, to give up the navigation altogether. The large steamers are scarcely eve vented at low water from getting to Prescott, though sometimes a bar below Pepin will get so shoal as to detain boats for some hours, or even days.

The trouble generally occurs just after a rise in the river. The moment the begins rising the sand-bars begin to shift; old channels are filled; the bottom stream flattens out, as it were, and when the water falls again, as it generall after a few days, the stream is spread over so great a width of river, and so bottom, that it is very shallow. In the course of time the water cuts for itself channel through the sand; and the concentration that thus takes place restor navigation to its usual condition until the new channel is again disturbed by These changes in the bed of the stream occasionally happen many times in the of a season. A boat may fight its way up to Saint Paul with the greatest difficu a falling stage of water, lie there a day or so, and, returning down stream, fi navigation much improved, though the water has been falling all the time, ow the cutting through of the sand-bars. Any acceleration in the current of the immediately causes a commotion among the sand-bars, which begin to travel stream. To insure the stability of the channel, therefore, it seems best not to cut off bends which occur in the same, but to endeavor, on the contrary, to redu current at the same time that the volume in the channel-way is increased.

I am of opinion that the safest plan of improvement will be, in general, to fi natural channel, and lead the water in that direction. An island in midstre nearly always, at its lower end, the seat of trouble. The two currents meet, an result is that the greater part of the water and the channel cross the river fro to bank at a sharp angle, and thus the section of the stream at right angles to i is so much lengthened or flattened that a shoal is usually the result. At Crat's a case of this kind occurs. The channel on the left of the island, which carrie water, crosses from the left to the right bank, and spreads out over the bars, l immense fan, with deep water off the outer edge of the reefs and a very shoal p over the crest of the bar near the foot of the island. As General Warren states report, the object of any works for improvement should be to help the river to the crossings. In many cases the closing of chutes would probably greatly in the navigation of the main river, and at Rollingstone Slough and some other such a plan has been recommended.

The improvement of the Mississippi River will require a good deal of time accomplishment, but need not be particularly burdensome to the Treasury. paratively small sum expended judiciously every summer, and at the most adva ous stage of water, would, in the course of a few years, work great changes in i ing the navigation. This is the policy of the European governments, and has, course of time, made rivers navigable for quite large steamers that would in thi try be thought scarcely worth improving.

At present the dredging-steamers do good service, but a single steamer, as at p employed, would be utterly inadequate, in a prolonged season of low water, t the relief necessary for uninterrupted traffic. I deem 4½ feet the utmost limit to any reasonably expensive system of improvements could be expected to deep navigable low-water channel. In this opinion I have the concurrence of most steamboatmen and of those well acquainted with the Mississippi River in its v stages. Even should it be found impossible to obtain a greater depth, the plan provements submitted would remain the same and only require extension to se greater depth.

CURRENT.

The current of the Upper Mississippi is remarkably gentle.

The subjoined Table I gives the velocities measured by me at various points survey.

That at Pig's Eye Island I expect to find a good deal increased since the comp of the dam which was finished last season, after our measurements were made.

Some of these velocities were measured with floats and some with current- The measurements were made at mid-depth, as near as could be attained, rare than 4 feet below the surface of the water.

The volumes of the river in cubic feet per second were measured at various and the results, together with the stage of water, as nearly as it could be gotten embodied in Table II.

TABLE I.—*Showing velocities of currents at various localities on the Upper Mississippi River.*

Locality.	Point on map.	Feet per second.	Miles per hour.	Stage.	Remarks.
Frenchman's Bar, 1½ miles below Saint Paul.	*a*	2.45	....	5.8	By floats at mid-depth.
	b	2.55	....	5.8	Do.
	c	2.42	....	5.8	Do.
	d	2.55	....	5.8	Do.
	e	2.66	1.81	5.8	Do.
	f	2.63	....	5.8	Do.
	g	2.66	....	5.8	Do.
	h	2.63	....	5.8	Do.
Pig's Eye Island, or Island No. 1: *Main channel.*	*a*	2.84	....	5.7	Current-meter.
	b	2.65	....	5.7	Do.
	c	2.80	1.91	5.7	Do.
	d	2.78	....	5.7	Do.
	e	2.24	....	5.7	Do.
Pig's Eye Island: *Chute*	*a*	2.26	....	5.7	Do.
	b	2.19	1.49	5.7	Do.
	c	1.89	....	5.7	Do.
Newport: *Chute*	*A*	2.45	1.67	5.2	Do.
Main channel: *Chute*	*B*	2.87	1.95	5.2	Do.
	C	1.97	1.34	5.2	Do.
Merrimac "A"	*a*	3.11	2.11	5.2	Do.
	b	0.35	0.24	5.2	Do.
Merrimac "B"	*a*	2.53	1.72	5.2	Do.
	b	2.65	1.80	5.2	Do.
	c	2.80	1.91	5.2	Do.
Hastings	*a*	1.65	1.12	4.3	By floats.
	b	2.17	1.48	4.3	Do.
	c	2.29	1.55	4.3	Do.
Hastings Bar	*a*	1.64	....	4.3	Do.
	b	1.71	....	4.3	Do.
	c	1.72	1.17	4.3	Do.
	d	1.71	....	4.3	Do.
	e	1.67	....	4.3	Do.
	f	2.06	....	4.3	Do.
Prescott	*a*	1.74	....	4.5	Do.
	b	2.50	....	4.5	Do.
	c	2.67	1.82	4.5	Do.
	d	2.38	....	4.5	Do.
	e	2.53	....	4.5	Do.
	f	2.17	....	4.5	Do.
Wabasha	*a*	4.08	....	4.5	Do.
	b	4.35	2.96	4.5	Do.
	c	4.17	....	4.5	Do.
	d	2.81	....	4.5	Do.
	e	2.30	....	4.5	Do.
	f	2.06	....	4.5	Do.
Winona "A"	*a*	2.04	....	3.1	Current-meter
	b	2.52	....	3.1	Do.
	c	2.73	1.86	3.1	Do.
Winona "B"	*a*	2.81	1.91	3.1	Do.
	b	2.15	....	3.1	Do.
	c	2.26	....	3.1	Do.
Mouth of Rollingstone Slough	*a*	1.93	1.31	3.1	Do.
	b	1.83	1.25	3.1	Do.
	c	1.77	1.21	3.1	Do.
	d	1.45	0.99	3.1	Do.

TABLE II.—*Discharge of river in cubic feet per second.*

Locality.	Discharge in cubic feet per second.	Stage, approximation.	Remarks.
Frenchman's Bar	20,091	5.8	September 3, 1874.
Hastings	15,332	4.3	September 25, 1874.
Hastings Bar	15,516	4.3	September 28, 1874.
Feet Prescott Island	32,001	4.5	September 30, 1874.
Wabasha	45,209	4.5	October 9, 1874.

LEVELS.

The levels not being as yet connected, I think it best not to present them until the gaps have been filled up and the necessary reductions made. From Saint Paul to

Prescott, the fall of the water-surface is 13.8 feet. The distance measured on th in the center of the river is about twenty-six miles. This gives an average fa mile of 0.53 feet = 6.4 inches. The air-line distance is only nineteen and on miles, which gives for the fall of the plane of the valley a slope of 8.5 inches pe This is a little more than Ellet gives for the descent of the Mississippi Valle Cairo to the Gulf of Mexico, which he estimates at 8 inches per mile.

Steamboatmen call the distance from Saint Paul to Prescott thirty-five mile taking into account the many abrupt turns which they are obliged to make in k the channel, it is probably not very far from the truth.

WATER-GAUGES.

It was thought necessary to establish several water-gauges between Saint Pa La Crosse, and the results of the observations, from the time they were put in closing up of the river by ice, are embodied in the accompanying profiles. It noticed that at Wabasha the result of strong up-stream or down-stream wi very apparent, owing, no doubt, to the influence of Lake Pepin, whose foot above Wabasha.

At Prescott, as a matter of interest, the open water at the foot of Lake Sain offered an opportunity for continuing gauge-readings all winter, and the fact t water fell to 0.3 feet of the scale allows the inference that its zero must hav pretty nearly correctly placed. I hope that we may be able during the coming to get at the true low-water marks of these gauges by observations taken dur low-water season.

PLANS FOR IMPROVING RIVERS BY WINGS.

There have been many attempts to regulate the channels of rivers in this c by means of wing-dams. These attempts have not always been successful, an generally been made on streams whose beds consist of rock or hard gravel bars. Europe that we must look for a perfected system of river improvements. Th hundreds of years, the regulation of streams offering all sorts of difficulties has necessity. It has been a study for generations of engineers whose successes a ures form an interesting chapter in the history of engineering. The French, t mans, and the Dutch have all contributed largely to the hydraulics of great rive have paid dearly for the knowledge they have acquired. It will be proper lay before you a few facts connected with the improvements made on Euro well as American rivers to justify the plans and estimates I herewith submit.

The preference as regards cheapness of construction, facility of repairing, an bility, seems, in streams with shifting sand-bars, to be given to those works wing-dams, &c., are composed of brush and stones combined. In streams of th character the use of single wing-dams has often been found a failure, and aban They frequently fail altogether to guide water in the direction intended, and add another dangerous obstacle to the already difficult navigation. The per deepening of the channel across troublesome sand-bars has been very succ secured by contracting the stream and causing scour to take place, the sand r being deposited in and between numerous wing-dams stretching out from the

This adds to the security of the dams, and at the same time confines the wate selected channel-way. In the course of time, by successive deposits of sand an sediment, the spaces between the wing-dams become dry shores, on which the of willows is encouraged, and finally, when sufficient soil has been deposited water, the willows give place to meadow-lands or forest. The action of thes may be compared to that of snow-fences, the shifting sands being caught in the formed by the dams. The object of the wings is to lessen the velocity of the along the shores so that it is forced to drop the matter carried with it in susp and build up new shores at the selected places. The production and regula shores, then, is the proper designation of this kind of engineering, though its o the regulation of the channel; art is substituted for main strength, and the made at the least expense to do the heavy work of moving immense quantities and digging for itself a deep and permanent channel.

I subjoin, as an example of the German practice, a copy of a plate to be fo Hagen's Wasser ban Künst, a most thorough treatise on the regulation of published in Königsberg, 1853, by the Brothers Borntraeger; also, later, by Er Korn, 1873, Berlin, Fig. 8.

In this example all the works were to be built in one season. The old c shown by the dotted line was to be abandoned, and the current thrown into the hand arm of the stream by closing up the chute on the left.

The beginning of this work was at O, where a protection was executed to p any further caving of the banks, when the main body of the stream was d upon it. At the same time the willows and brush upon the island were roote far back as the dotted line, to prevent any further deposit of sediment up

island, and to facilitate its washing away. These works completed, the next step was at J, where the upper wing-dam, being constructed quite strongly, allowed of the other two being lighter and cheaper. This gave the first impulse to the passage of the water down the right-hand chute, since, the deep hollow being removed, the current had less tendency toward the left bank.

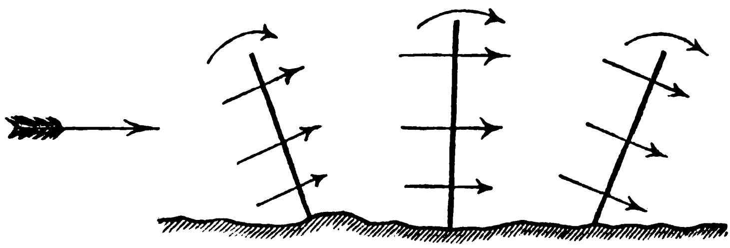
Next came the construction of the works at K, to induce the silting up of the head of the chute. Care was taken here not to entirely close the water-way, but only to arrest the current somewhat, that the silting up might be gradual and distributed over the whole length of that arm of the river. To this end a low dam at F, allowing the passage of the water at quite low stages, is built, and at N three more wing-dams.

The effect of all these works on the left bank was to build out the shore to the dotted line designed as the new limit of the river, and gradually to silt up the whole of the chute.

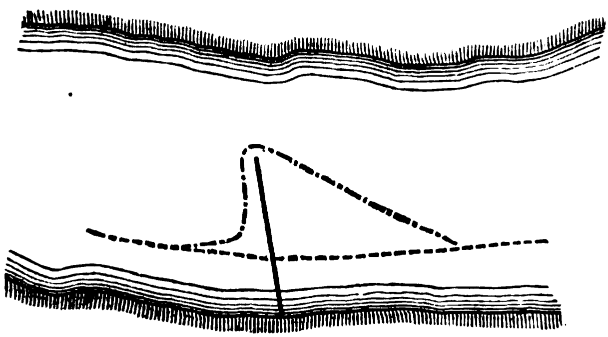
When sufficiently raised above low-water stages the planting of willows caused a continual and rapid accumulation of sediment, and in the course of time put all danger of the return of the river to its former channel out of the question. The filling up of the concavities and irregularities at G and H was the last work of the construction. At LM it was found necessary to dredge a narrow channel for the passage of boats at the time when the river was first shut out of the left chute, and had not yet removed the bar at that place.

This is an example of the general plan adopted in the more modern improvements of the German rivers, and has proved itself the cheapest and most certain of lasting success. It will be noticed that in the accompanying plate the wings are all directed up stream at a slight angle with the axis of the current.

The object of this is to prevent the water passing over the dam at high stages from attacking the banks below the foot of the dam, and endangering its connection with the shore, thus:

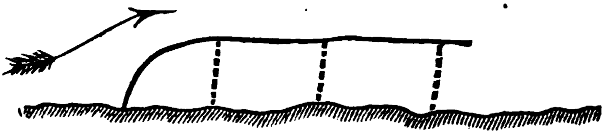


The distance between the dams is a matter of judgment and experience.



If too far apart the dams are like single wing-dams, and the current suffers all these disturbances which single dams are liable to cause. If too close an unnecessary amount of money is expended to accomplish the desired results. Some writers have stated that the distance between should not exceed four to six times the length of the dams. The distance between is, however, more probably a function of the width of the stream (to be safe, not more than one-third of the width) and dependent on the direction in which the stream meets the works. If the current is normal to the wings, they may be wider apart; if directed upon the heads of the wings so as to pen-

etrate between them, then the intervals should be less. It often becomes necessary after the completion of a system of wing-dams, to add another wing or two so as to check any too great tendency to form eddies and prevent the deposit of sand in the desired places. These cut-offs are of much lighter construction than the wings, which are opposed to the full current, as the subjoined drawings will show. The French have on a great many of their rivers built long wings for confining the channel. These are



left open at the lower ends, and secure a good depth of water along their outside, but are particularly liable to being undermined where the foundations are insecure (as in a sandy stream), and it is found that the deposit behind the wing is very slow in taking place. The current at high stages, passing over the crest of the wings, attacks the banks along which it extends and runs with sufficient velocity to carry off the matter thus excavated. So much is this the case that they have often been obliged to build cross-weirs to connect it with the banks. At low-water the deposit ceases entirely, since no current enters, and the wing thus remains unsupported and liable to continual breaks and repairs.

CONSTRUCTION OF THE WINGS.

The brush construction that I have before referred to as cheapest and best has a good many different varieties; the brush is, however, nearly always made into fascines of such a length that, placed on their butt-ends, their center of gravity shall be at the height of a man's shoulder when he stoops slightly to raise them from the ground Fig. 10). The length of a single fascine is therefore about 10 feet. Large fascines are used in some cases where the core of the fascines consists of cobble-stones or coarse gravel. These are made from 12½ to 18 feet long, and 2½ to 3 feet thick, and are rolled out upon the wing as it progresses. These fascines are applied in many different ways, and are really but a substitute for rock in places where the latter is difficult to get. They are bound together by so-called "wursts," or brush-ropes, to which they are pinned with treenails. (See Figs. 11 and 9.)

The crown of these wings should be built on an incline rising toward the shore, but always at the shore-end kept a little lower than the bank. This prevents the disas-

trous effect of a thin, unbroken stream flowing over the whole length of the dam at medium stages, and keeps the water crowded toward the selected channel. The dams are customarily built 2 to 3 feet higher than the low stage of water, and in general it is necessary, in working from the banks outward, to have the crown out of water in order to build the successive layers of fascines. The batter given to the upper and lower faces of the wings varies considerably, but a slope of 1 to 1 is often assumed and answers very well, particularly as a very accurate preservation of any particular slope is out of the question and not of great importance. Figs. 1 and 2 show how the successive layers are built. At *a* (Fig. 2) we see the outer layer lying on the surface of the water ready to be loaded with sand and gravel and sunk. In Fig. 1 it is shown in plan as sunk. We see, also, that the immediate sinking of a layer is not to be desired, and the last five or six must be progressively sinking nearer and nearer to the bottom, since in a swift current the possibility would be very small of holding such an easily-broken mass as that of a number of fascines pinned together, and keeping them from being twisted away from the preceding and solid part of the construction. When the sinking progresses gradually, however, the figure shows for itself how the fascines mutually support each other. Care must be exercised not to get the slope of the layers of fascines too steep, otherwise the sand or gravel which is placed between falls out, and is carried away by the current. Each succeeding layer covers and protects the end on top of the preceding one from washing away. At the outer end a protection of

riprap, or of fascines filled with stone, is necessary to insure the stability of the last layers. Finally, when the brush-work is completed a covering of broken stone or coarse gravel protects from injury by ice or floating objects. Lighter forms of wings, to be used in shallow places or where deposit has already taken place between the main wings, are shown in Figs. 5, 6, and 12. Little explanation of these is necessary.

The European constructions mentioned above are adapted to both great and small depths. On portions of the Rhine, where such dams have been constructed, the water is subject to a rise of 25 to 30 feet in twenty-four hours, and the fact of the dams holding their places under such circumstances is sufficient evidence of their strength.

BANK-PROTECTIONS.

Where quantities of loose rock are not attainable, brush protections are used, and are built in much the same way as those on the Fox and Wisconsin Rivers. The improvements lately carried out on these rivers show the efficacy and stability of brush-dams.

The United States Engineers have there employed the fascine construction to great advantage, and so firmly does the brush become anchored in the sand that the removal of a dam, when this became necessary, has proved a difficult matter. They have withstood floods of 10 feet above their crests, under the most unfavorable circumstances. These were, however, nearly all low dams. In them the fascines were laid side by side, with the butt-ends down stream, and lapping under each other so as to make a slope. They were built to 1 foot above low water, but it seems that this was afterward judged to be too little, and some of them were raised a foot. The fascines were made into rafts or mats by tying them together with light poles bound on with cord.

ILLINOIS RIVER DAMS.

On the Illinois River a simpler form of brush-dam, and one which has answered well, is constructed as in the annexed figures (Figs. 15 and 16). I think that for a stream with an even bottom this construction will be as stable as that made with fascines, and cheaper to build—the cost of labor required in making fascines being greater than it would be in Europe. The great disadvantage of the Illinois River dam appears to me to be its want of elasticity by which to fill up hollows occurring under it. The bottom of the Mississippi is so even, however, in most places that I consider this disadvantage of less importance. I have made my plans and estimates upon the basis of the Illinois River construction, and with the bank-protection, as in Fig. 19, used at Alton Slough by General Simpson.

Brush, per cord	$2 25
Stone, per cubic yard	2 00
Earth, per cubic yard	35
Piling, per linear foot	15

The gentle current of the Upper Mississippi will, I think, give full security to these dams, but should they fail the fascine construction can be resorted to. These weirs will rarely be constructed in over 10 feet of water—a depth that will be continually diminishing with the age of the dam. The protection of the ends of the wings is to be secured by means of piling and riprap, as in Figs. 17 and 18.

I think it possible that we may be able to reduce the cost of many of the wings by building them slighter where they are found to be in positions not much exposed to the current, but have not thought it advisable to take this into account in the general estimate. A number of the bars surveyed by us do not appear at present to require any improvement to secure 4½ feet of water, and it will be impossible to estimate for their improvement until such time as they may again become obstacles.

The dotted red lines on the tracings show the shores which it is proposed to secure, and the wings or weirs are drawn in black.

The shifting nature of the channel is well shown by the small sketches appended of Beef Slough and Rollingstone, which give the channels as run in different years. (Figs. 20 and 21.)

A protection to the banks will, in many cases, prove necessary after the dams are built. It is impossible to predict with certainty the exact amount of work needed, but I have added a sufficient sum to the estimates to cover the cost of such constructions.

I append a description of the various bars between Saint Paul and La Crosse, which will be interesting here as showing the number of points that will eventually need improvement. These localities have been designated by pilots and river experts, and a good many places are mentioned where 4½ feet at present could be had at low water, except, perhaps, in such extraordinarily dry seasons as that of 1864.

Such droughts occur so seldom as to be of scarcely any importance in our plans of improvement; not oftener, probably, than once in forty years.

DESCRIPTION OF THE BARS.

Frenchman's Bar.—This is a reef just below Saint Paul, evidently caused by the widening of the stream below Dayton's Bluff. The wings are intended to confine the current, and are indicated on the tracings herewith presented. Cost of wings, $4,417.86.

Pig's Eye Island Bars.—These bars have always been a serious obstacle to navigation. The spreading of the water above and below the island has formed shoals, on which steamers were at low stages frequently detained and obliged to lighten or spar over.

The equal division of the stream made bad navigation in either arm when the water was low, the channel being found sometimes on one, and sometimes on the other side of the island.

A pile and riprap dam was thrown across the head of the left-hand chute last season, and will, it is thought, have materially improved the channel on the right by the time low water sets in this year. It was thought best to add wings above and below the island, in accordance with the general views already indicated in this report; and should they be needed, will give, it is thought, a good 4½-foot channel. Cost of wings, $1,913.10.

Kaposia Bar.—This bar, like those immediately below it, the Upper and Lower Red Rock Bars, is caused by the crossing of the channel from bank to bank. The Upper Red Rock Bar has at times been the worst on the river. The maps explain fully the plans for bettering the channel, and it is only necessary to call attention to the rocky ledge on the left bank, along which the channel is from 12 to 20 feet deep, to show that the river is capable of furnishing abundant water for navigation wherever a narrow and permanent water-way can be secured.

The stone is of quite excellent quality for riprap, and can be quarried and loaded into boats without difficulty.

Cost of wings at Kaposia	$2,425 34
Cost of wings at Upper Red Rock	3,140 04
Cost of wings at Lower Red Rock	2,796 12

Newport Bar.—Above the little town of Newport the river divides, and pours part of its water through a chute.

The map explains the method of improvement, as also at Merrimac, where a case of the same kind occurs.

Cost of wings at Newport	$2,259 36
Cost of wings at Merrimac	2,798 36

Robinson's Island Bar.—This is sometimes called the "Head of Gray Cloud," since Gray Cloud Slough leaves the river just opposite the small island. It is thought best to leave the channel as it at present exists, near the rocky cliffs of Gray Cloud Island, only confining the water somewhat by wings on the right bank, in order to cut out the bar at the upper end of the island and make a good raft-channel. There have been great changes here since General Warren's surveys of 1867, and the channel has shifted from the right to the left of the island many times. It is thought that the contraction of the water-way will cause the island to disappear; but if it does not, it should be removed either by scraping, or, if rock is found, by blasting, and the rock used in the construction of the wings. Cost of wings, $3,414.20.

Pine Bend Bar.—This place is quite often very shoal. A large sand-bar forms a mile or more above the islands and moves down during successive seasons, so that about once in five seasons it reaches the narrow channel between the islands and the right bank and disappears. A new bar has in the mean time formed above, and goes through the same process. While these changes are going on the channel is continually shifting. The plan of improvement consists in straightening the course of the stream, and confining the water to the channel on the right bank. Cost of wings, $7,622.86.

Gray Cloud Bar.—This is not often a bad place, and it is not thought necessary at present to survey or render estimates for its improvement.

Boulanger's Bar.—This bar is seldom troublesome, but will require deepening. Our soundings along the left bank show rock, either bowlders or in place. The wings will, it is thought, give sufficient water without removing the rock. Cost of wings, $2,307.44.

Head of Nininger Bluff Bar.—At this place a small island has formed, behind which the Nininger Slough heads, and withdraws quite a considerable quantity of water from the main stream.

The steamers have lately been forced to take the narrow channel around the island, and so confined is it, that the banks are literally worn off by the rubbing of the steamers' guards. An old barge was loaded with rock and sunk in this channel last season by your orders, and it remains to be seen what effect it will have upon the main channel. The map explains the further improvements contemplated. Cost of wings, $5,223.35.

Nininger Bluff—Nininger and Hastings Bars.—These are ordinary reefs, caused by a

wider reach of river than can be well supplied with water at low stages. The maps speak for themselves as to the mode of improvement.

Cost of wings at Nininger Bluff	$2,770 60
Cost of wings at Nininger	6,399 40
Cost of wings at Hastings	2,850 08

Prescott Island Bar.—The same trouble exists here as at the head of many of the islands of the Mississippi. General Warren, in his report, advised the closing of the right-hand chute; and that appears still to be the proper method of improvement, with a few wings above to somewhat contract the width of the river and assist in silting up the head of the chute. Cost of wings, $5,335.66.

Diamond Bluff.—At this place, some eight to nine miles below Prescott, there used to be a bar which, during one season, gave trouble. It has since disappeared, nor could we find any evidence of improvement at this place being needed. The bar was some two miles above the town. Just at the town, I was told, a rocky ledge extends out into the river from the left bank, and at low water causes some inconvenience from the narrow water-way left for the passage of boats. The depth being, however, always abundant, I have not contemplated removing the rock. The river is good from this place to the head of Lake Pepin, at Wacouta, in all seasons.

Wacouta Bar.—A little hamlet, called Wacouta, is built at one of the mouths of the river emptying into Lake Pepin, and gives its name to a shoal and an arm of the delta which the Mississippi forms here. The shoal gives little trouble, and, as the middle channel, which pours the main volume of the stream into the lake, has excellent navigation at all stages, it is thought that a light placed on the sandy point, to enable steamers to find the entrance to the middle channel at night, will be all the improvement necessary. The light is now placed on a point below the Wacouta or South Channel. It was first lit in May, 1875.

Bar below Read's Landing.—The river receives here one of its largest tributaries, the Chippewa. Our survey shows no improvement needed at this place, nor at the "Bar above Wabasha."

Bar below Wabasha.—This is a bad and most inconvenient bar, where steamers have to cross the river almost at right angles to get into the chute to the left of Crat's Island, and the navigation of large rafts is particularly difficult. The channel on the right of the island is good until near its foot, where sand-bars make bad shoals in low stages. As the upper part of this chute has a hard, gravelly bed, not subject to changes, the "Bar at foot of Crat's Island," as well as at its head, can be avoided altogether, it is thought, by the construction of wings, as given on the accompanying maps. This plan has the advantage of cheapness, and also that it will not interfere with the working of boats in the present channel. Cost of wings, bar at foot of Crat's Island, $7,485.59.

Beef Slough Bars.—This place has long been one of the worst on the Mississippi. The river widens and is divided by many islands. The small sketch, Fig. 20, gives a good idea of it, together with the plan for its improvement, and the various channels that have at different times been used by steamers and rafts.

Some local interests may be injured by the closing of the Beef Slough Cut-off, as a small steamer runs from Alma to Wabasha by way of Beef River and this cut-off, and it is possible that the mill-owners and logging companies on Beef River may object to having this convenient passage closed up. It will, however, be, no doubt, to the advantage of the general navigation, and, if found necessary, means can be devised for allowing the passage of this small steamer (only 50 or 60 feet long), while most of the water is cut off from Beef River. It is not expected that after the wings are completed the banks will remain stable in this locality, and it is better that they should be cut away in some places, and, when the regular shape indicated on the map has been reached, riprap can be applied to prevent further wasting. Cost of wings, $12,747.28.

Alma Bar.—Above Alma the channel has changed in the last two years, and the best water is now found to the left of the islands, at the mouth of Beef River. The bars in this vicinity belong to the general term of Beef Slough bars, given to the reach between Crat's Island and Alma, and are at times troublesome. The old channel, which occupies the main river, appears the most natural to improve, and will afford the easiest navigation. I refer to the plans as explanatory of what is recommended for the improvement. Cost of wings, $15,130.94.

Pine Island Bar.—No improvement was found to be necessary here, the depth being at present sufficient; also in the same category were found to belong the following bars:

Above West Newton.
Head West Newton Island.
Above Minneiska.

Mount Vernon Bar.—The long shallow crossing at Mount Vernon will require a contraction of the width of the stream as in the plan. Cost of wings, $5,151.10.

Chimney Rock Bar.—The river is here divided by islands, and with the usual result.

I learn that there has been for some years but little trouble experienced at this p and the survey shows 4½ feet at low-water at present.

Rollingstone Bars.—Here is a reach of the stream very similar to that at Beef Slo The present channel is behind the islands, on the right bank, and is extremely na and inconvenient. There are lumber interests which would be in conflict with closing of the Rollingstone chute. At low-water, however, these people are oblige take their rafts down to Winona by the outside channel, and could of course do other stages.

Some adjustment of this difficulty will have to be made, as the plan recomme demands the closing of the chute. Cost of wings, $12,706.06.

Betsey's Slough Bar.—Island No. 65 here divides the river into two channels, w have alternately been used by steamers. Of late the bar at the foot of the left- chute has become so shoal that large steamers have been obliged to take to the side of the island. A very shallow bar at the head of the right chute offers but more inches of water than the bar at foot of Betsey's Slough (left-hand chute), the latter excepting this bar being from 12 to 18 feet in depth in mid-channel. The of improvement is evident from the map. It is probable, though not certain, t large amount of riprap will have to be used on the concave bank below the isla prevent abrasion after the improvements have been made. Cost of wings, $4,651.

Wild's Bar.—This bar is just below Betsey's Slough, and is due to a lack of merely. The plan which provides for leading the water off from the small chann the right of the island into the main channel will, I think, give the needed r Cost of wings, $3,845.50.

Argo Island.—Here there appears to be no improvement necessary at present. same is true of the bar above Winona; Elevator Bar below Winona; bar above neopa, and bar below Homer.

Mount Trempe à l'Eau Bar.—A slight improvement here will, it is thought, de the bar at the head of Island No. 81 sufficiently to give 4½ feet of water. (See p Cost of wings, $5,402.30.

Bar below Trempe à l'Eau.—This has been quite a serious obstruction in former y though not recently or at present. No improvement is now needed.

Queen's Bluff Bar.—The river here needs contraction, and is provided for as in Cost of wings, $5,897.18.

Bar below Dresbach.—Here is again one of those cases where an island (No. interferes with the course of the stream. It is thought that the slight constructio the foot of the right-hand chute will give all the relief needed; and, as the chann straight though narrow one, it will be shorter and more convenient than that n use. Cost of wings, $5,309.04.

The two bars mentioned as Nos. 43 and 44 (head La Crosse Chute and bar La Crosse) were not reached by my survey of last season, the cold weather causi to suspend operations.

Table III gives the numbers and names of the various bars between Saint Minn., and La Crosse, Wis.; the cost of wing-dams for each bar, exclusive of shore-revetment or protection as may be found necessary after completion of d and the available depth on each bar, as given by pilots, at low summer-water.

TABLE III.

No.	Name of bar.	Cost of wings.	Dept low
			Fe
1	Frenchman's	$4,417 86	
2	Pig's Eye	1,913 10	
3	Kaposia	2,425 34	
4	Upper Red Rock	3,140 04	
5	Lower Red Rock	2,796 12	
6	Newport	2,259 36	
7	Merrimac	2,798 36	
8	Robinson's Island	3,414 20	
9	Pine Bend	7,622 86	
10	Gray Cloud	....	
11	Boulanger's	2,307 44	
12	Head Nininger Bluff	5,223 35	
13	Nininger Bluff	2,770 60	
14	Nininger	6,399 40	
15	Hastings	2,850 08	
16	Prescott Island	5,335 66	
17	Diamond Bluff	....	
18	Wacouta	....	
19	Below Read's Landing	....	
20	Above Wabasha	....	
21	Below Wabasha	....	
22	Crat's Island	7,485 59	
23	Beef Slough	12,747 98	
24	Alma	15,130 94	

TABLE III—Continued.

No.	Name of bar.	Cost of wings.	Depth at low water.
			Feet.
25	Pine Island	....	4
26	Above West Newton	....	4
27	Head West Newton Island	....	4
28	Minneiska	....	4
29	Mount Vernon	$5,151 10	3½
30	Chimney Rock	....	4
31	Rollingstone	12,706 06	4
32	Betsey's Slough	4,651 04	3½
33	Wild's	3,845 50	4
34	Argo Island	....	4
35	Above Winona	....	4
36	Elevator below Winona	....	....
37	Above Minneopa	....	....
38	Below Homer	....	....
39	Mt. Trempe-a-léau	5,402 30	....
40	Below Trempe-a-léau	....	....
41	Queen's Bluff	5,897 18	....
42	Below Dresbach'	5,309 04	....
43	Head La Crosse Chute	....	....
44	Above La Crosse	....	....
	Total	133,999 80	....

No estimates are made for those bars against the names of which no sums are placed, as they were found by us to be at present in no need of improvement, giving at least 4½ feet of water for low-water navigation.

The cost of riprapping, or otherwise protecting such shores as appear to need it after the completion of the works, is estimated at $78,000.

It will be observed that these improvements cover a stretch of river reckoned by the steamboat distances of nearly two hundred miles in length, and is the portion which has heretofore been either difficult or impossible to navigate during the low-water season.

Below La Crosse obstructions exist, but they are far apart, some stretches of fifty to sixty miles requiring no improvement to bring them up to the standard of 4½ feet.

The completion of the Fox River improvement will make the improvement of the Upper Mississippi of even more importance than it is now, the trade between Chicago and the Northwest being immense.

An appropriation of $50,000, to begin with, would enable us to test the soundness of the views expressed in this report, and I would suggest that the first improvements be made at Crat's Island and Betsey's Slough.

These two points have long been among the worst bars on the upper river, and success here will fully justify the views set forth in this report, and prove that it is not impossible to secure 4½ feet navigation from La Crosse to Saint Paul, but actually quite possible, and at an expenditure far below what has ordinarily been thought it would involve. Those bars which at present have 4½ feet of water offer no peculiar difficulties, nor would the cost of improving them, should they become obstructions, be more than the average cost of those for which estimates have been made.

My estimates apply only to those obstructions existing at the date of survey, and I submit them as follows:

ESTIMATE OF COST OF IMPROVING THE CHANNEL OF THE MISSISSIPPI RIVER BETWEEN SAINT PAUL AND LA CROSSE, TO GIVE 4½ FEET NAVIGATION AT LOW WATER.

Wings and dams	$133,999 80
Riprapping shores as needed	78,000 00
Scraping with Long's scraper	75,000 00
Engineering	30,000 00
Contingencies, 10 per cent	31,699 98
	348,699 78

In conclusion, I would remark that the cost of keeping up these works should not be excessive, and it is thought that the United States steamer and crew now employed in removing snags, &c., could, without much additional cost, assume the duty of repairing the dams and riprapped shores whenever they required it. An appropriation of $100,000 would enable us during the first year to improve the very bad portions of the river above Prescott, and also the two points, Betsey's Slough and Crat's Island, mentioned before as good places to test the method of construction advocated in this report. I would, therefore, respectfully suggest that this amount be asked for.

The plans and estimates for the Mississippi River improvement between La Crosse, Wis., and Alton, Ill., cannot be completed until the close of the ensuing season.

I remain, sir, very respectfully, your obedient servant,

M. MEIGS,
Assistant Engineer.

Col. J. N. MACOMB,
Corps of Engineers, U. S. A.

PRELIMINARY REPORT.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., January 12, 1875.

GENERAL: The following preliminary report by Assistant Engineer M. Meigs upon the survey of the Upper Mississippi River is respectfully forwarded to the Chief of Engineers as showing the extent of the operations for the past working season, as far as the same can be shown prior to the completion of the maps and diagrams required for closer estimates.

I approve of the suggestion of Assistant Engineer Meigs, that the work should be commenced and conducted by hired labor until such progress shall have been made as will show on what basis contracts can be safely let in case it should eventually be deemed economical and advantageous to do the work by contract.

A steamer will be required expressly for this work; but doubtless the United States steamer Montana could render valuable assistance in the outset, and hence the necessity of having her repaired as soon as possible, as estimated for in another communication from me to-day.

As dredging will be needed in conjunction with the building of wing-dams, the Montana is peculiarly fitted to assist in this work at once; but in case the water should be low in the river, her services would be demanded at various points for assisting the navigation, as has been the province of that boat for years past, and steamboat-men would probably protest against her being withdrawn from the general duty of keeping the channel open.

It is therefore hoped that a steamer may be provided for according to the estimate for this special service.

All of which is respectfully submitted.

J. N. MACOMB,
Colonel of Engineers.

Brig. Gen. A. A. HUMPHREYS,
Chief of Engineers, U. S. A.

REPORT OF MR. MONTGOMERY MEIGS, ASSISTANT ENGINEER.

ENGINEER OFFICE, UNITED STATES ARMY,
Rock Island, January 6, 1875.

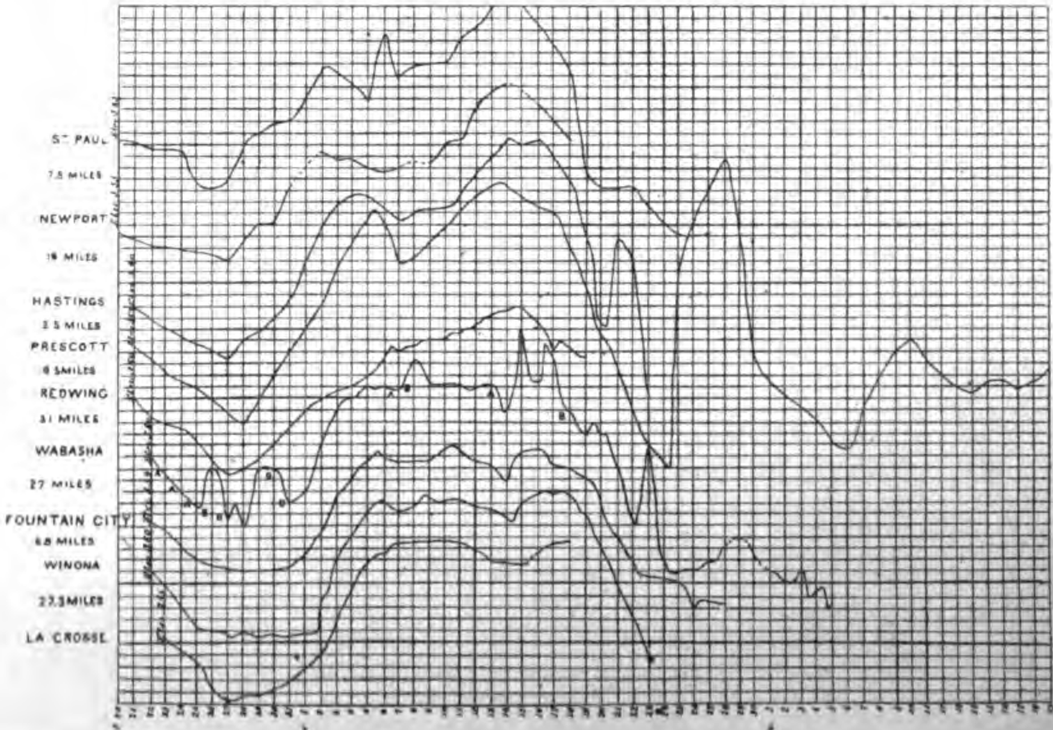
SIR: In the present uncompleted state of my maps and notes it is impossible to make any satisfactory estimate of the cost of the whole improvements contemplated by the Committee on Transportation-Routes to the Seaboard on the Upper Mississippi.

It is to be remembered that no improvements of the kind, or on the scale of those that would be necessary on the Upper Mississippi to secure 4½ to 6 feet of water, have yet been constructed in this country.

It is a work of such importance and magnitude that it should not be undertaken without some previous experiments. I would suggest that two or three points on the river which now impede navigation the most should be selected for improvement.

Rollingstone Bars, Beef Slough Bars, and Betsy's Slough Bars are three such points, or, perhaps, rather, some of the bars above Prescott where the river is smaller.

PROFILES OF WATER GAUGES



A. *Wind up Stream*

B. *Wind down Stream*

Fig. 1

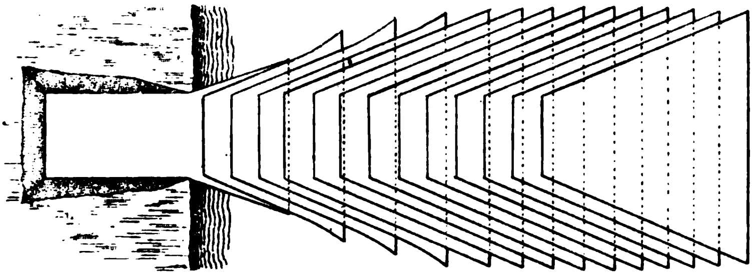


Fig. 2

Fig. 3

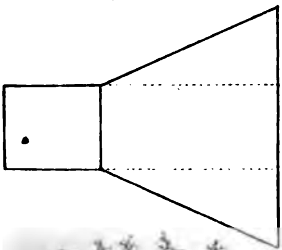


Fig. 4

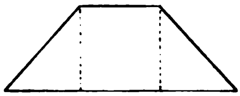


Fig. 5

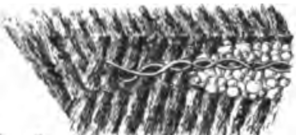


Fig. 6

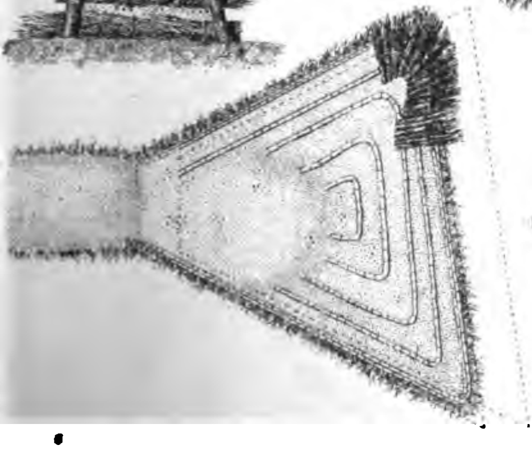


Fig. 7

Fig. 8

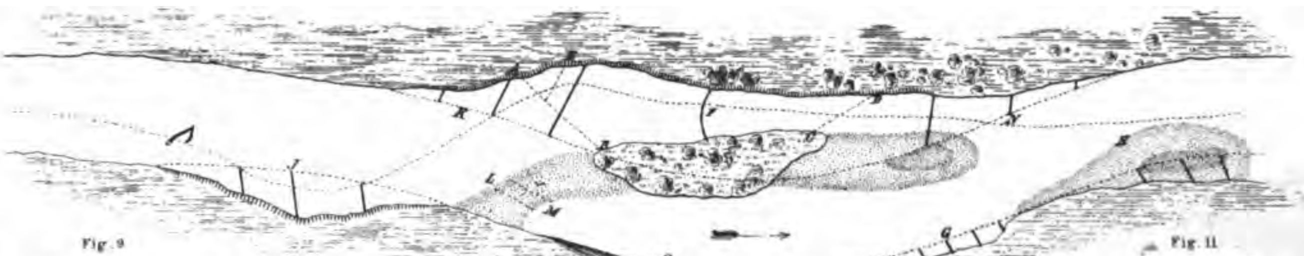


Fig. 9

Fig. 10

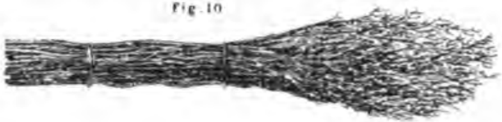


Fig. 11

Fig. 12

Fig. 13

Fig. 14

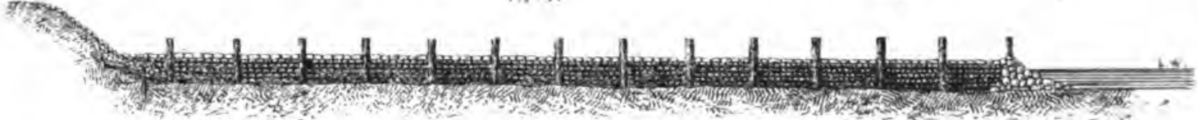


Fig. 15

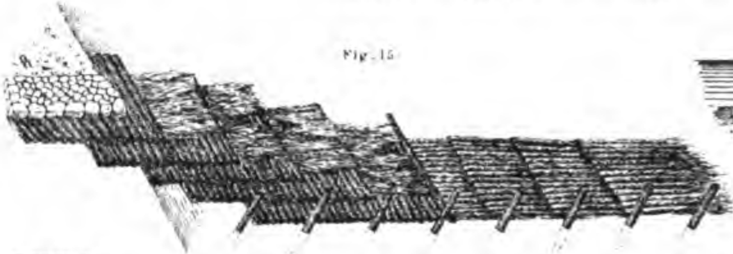


Fig. 16

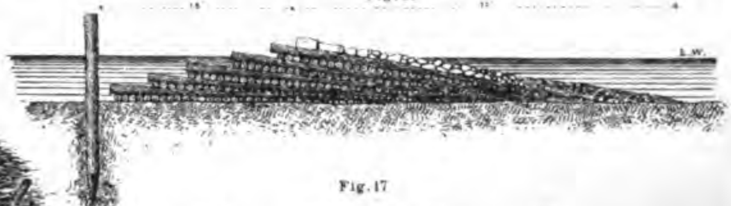


Fig. 17

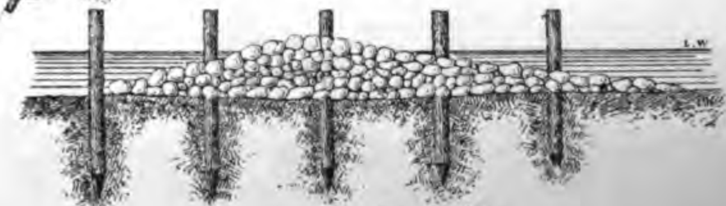


Fig. 19

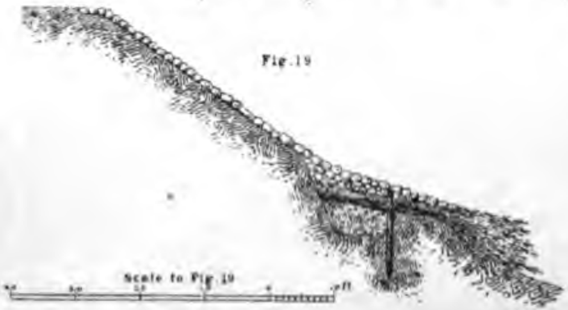


Fig. 18

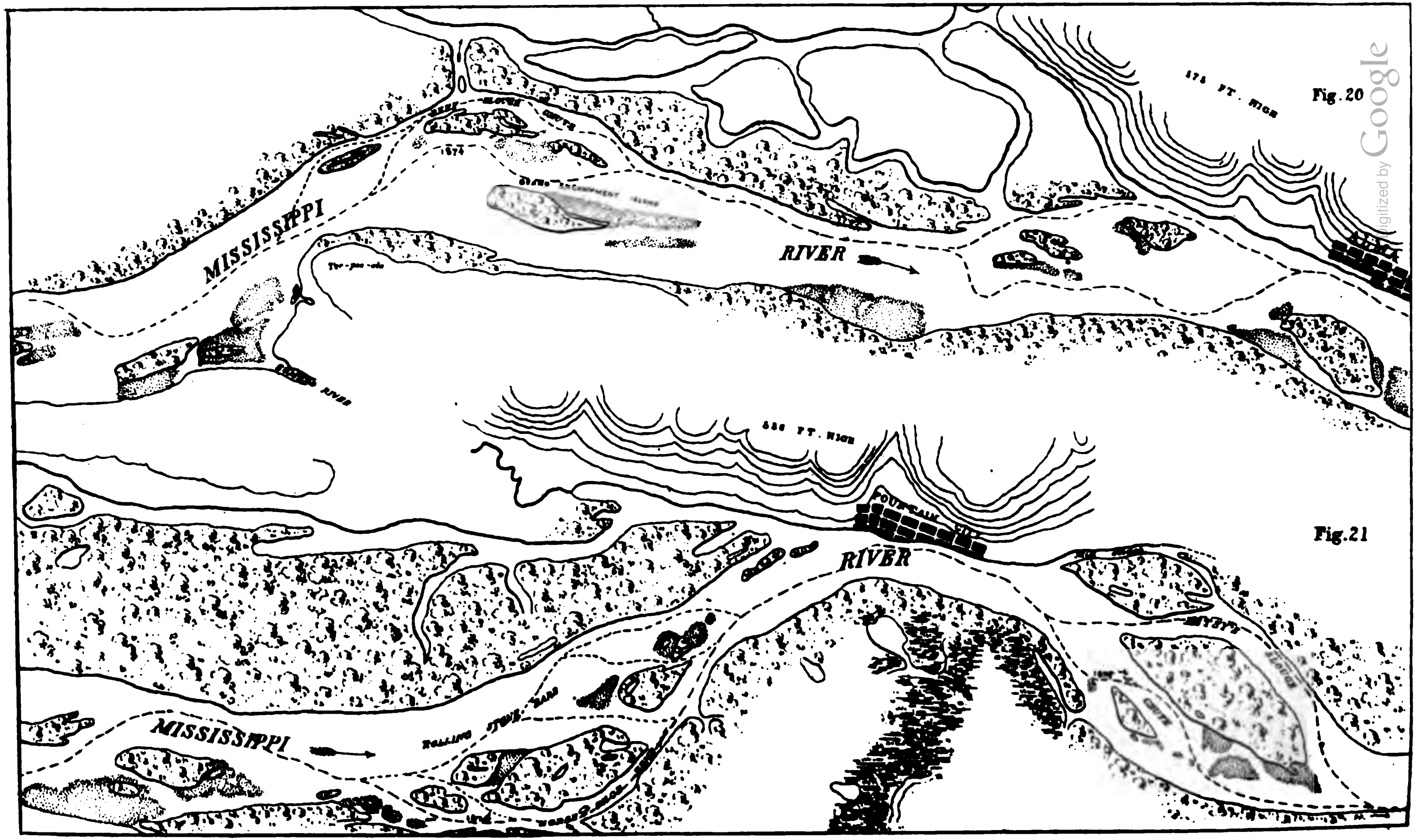


Fig. 20

Fig. 21

Should it be found possible to secure 4½ feet of water at these points, I feel sure steamboat-men will feel satisfied, and they will be able to navigate these difficult points more readily than they now do the Rock Island Rapids, where 4 feet of water is provided for.

I would suggest that in asking for an appropriation it be left discretionary with the Engineer Department what points on the upper river are to be improved, as from the shifting nature of these bars the difficulties are liable to cease at one bar and occur at some other place, after any great freshet in the river. Still it may be said that the serious difficulties at low water are above La Crosse, and particularly above Winona.

It might perhaps be better to begin up at Saint Paul and work downward.

The Pig's Eye Bar has been improved experimentally already, and its results ought to be carefully considered.

The United States steamer Montana might be used to do the necessary dredging in connection with these improvements, but it would be better to have an independent steamer, since in case of low water the Montana would be required to do the usual work in which she has been engaged.

The only successful improvements of streams with shifting sand-bars, such as the Mississippi, have been made in Europe on the Upper Rhine and Danube (see Stephenson's Canal and River Engineering, 2d ed., p. 151). These works were of great extent and attended with, perhaps, greater difficulties than those the Mississippi offers, owing to the greater height of their floods. The spurs, diversion-arms, &c., in these improvements were entirely constructed of bundles of fascines, weighted with stones and earth, and were made with great rapidity and economy. This style of improvement offers particular advantages on the Mississippi, where the brush, &c., can be had in any quantity, and it would, no doubt, be the most economical method that could be employed.

It would be necessary to make some resurveys for these improvements, and for a thorough examination of points of difficulty between La Crosse and the mouth of the Illinois River.

In view of these facts, I would suggest the construction of a light-draught steamer for dredging, &c., at Pittsburgh.

This will soon be necessary to replace the Montana, now pretty well worn out, and can be employed for the present on the contemplated improvements. There are forty-three bars between La Crosse and Saint Paul, acknowledged as obstructions, more or less serious, by the steamboat-men at present employed on the river. In my opinion it will cost at least $500,000 to improve these points, to secure 4½ feet water (abundant for the present requirements of navigation).

I therefore submit the following estimate of the amount that could be advantageously expended next year, and suggest, for the more economical expenditure of the money, that the work be executed at first under the personal supervision of the Engineer Department, until some experience is gained that will be a guide for the letting of contracts.

ESTIMATE.

Engineering, completing maps, &c	$15,000
Cost of steamer, with Long's scraper	35,000
Expenses of same for one year	20,000
Cost of brush-dams, piling, &c	60,000
Contingencies	13,000
	143,000

I would say that I cannot complete my plans and estimates for the work above La Crosse until May, and examinations remain to be made below that point.

I remain, sir, respectfully, your obedient servant,

M. MEIGS,
Assistant Engineer.

Col. J. N. MACOMB,
Corps of Engineers, U. S. A.

ROCK ISLAND RAPIDS.

ROCK ISLAND, ILL., *January* 11, 1875.

GENERAL: As bearing upon the subject of plans and estimates for the improvement of the Upper Mississippi River upon the scale suggest-

ed in the report of the Select Committee of the United States Sen upon Transportation-Routes to the Seaboard, I beg leave to present he with a tabular statement showing the cost of the work of improving R Island Rapids, the amount required yet to complete that work, and additional amounts that would be required to secure additional dep as suggested in the report of the select committee above referred This tabular statement, which gives a clear exhibit of the cost of ex ing and additional improvements at this point, was drawn up by Ass ant Engineer E. F. Hoffmann, who has been identified with this worl improvement since its commencement; and it is founded upon his s veys made from time to time for the purpose of measuring contract work, and showing the best means of continuing the improvement.

The work of cutting the channel through the rocky chains wh were found obstructing the navigation in this limited district of so fourteen miles of river was projected on the basis of affording a ch nel of 200 feet in width and 4 feet in depth below the water-surf of the low stage of 1864. These dimensions were adopted by a Bo of Engineers after consulting with persons engaged in the river n gation, and after considering the wants of navigation of the upper ri and were deemed ample as affording better navigation than could depended upon as to be found in the river above. The plan as far perfected has given great satisfaction to those engaged in navigat the river.

It will be seen that a deepening of only six inches, so as to give c 4½ feet at lowest water, would cost over half a million of dollars, s nearly half as much as the satisfactory channel now nearly comple I would, therefore, respectfully recommend that the existing scheme improvement for Rock Island Rapids be adhered to, at least until a it shall have been shown that a greater depth can be secured and ma tained through the sand-bars above.

I remain, very respectfully, your most obedient servant,

J. N. MACOMB,
Colonel of Engineer

Brig. Gen. A. A. HUMPHREYS,
Chief of Engineers, U. S. A.

Rock Island Rapids of the Mississippi River.

The work of improving the Rock Island Rapids of the Mississippi River, now nearly completed, has been conducted on the basis of affording a navigation of 4 feet in depth below the low-water surface of 1864, and has cost, thus far, about	$1,050
Amount required to complete the project	80
To afford 6 inches greater depth through the rocky chains, so as to give a depth of 4½ feet, would cost an additional amount of	507
To afford 1 foot greater depth through the rocky chains, so as to give a depth of 5 feet, would cost an additional amount of	1,102
To afford 2 feet greater depth through the rocky chains, so as to give a depth of 6 feet, would cost an additional amount of	2,403

DES MOINES RAPIDS.

ROCK ISLAND, ILL., *January* 26, 187

GENERAL: I beg leave to present herewith a report of Capt. A Stickney, Corps of Engineers, made by my direction, touching the of the canal, &c., around Des Moines Rapids of the Mississippi Ri

and the cost of deepening this canal, &c., 1 foot, so as to get a depth of 6 feet at low water through this improvement.

An examination of this report shows that this great work (which is now nearly finished), when completed under the existing plan, will have cost something over $4,000,000, and that to alter it so as to afford an additional foot of depth will cost nearly one-fourth as much as the completed work, besides being attended with serious loss of time before the work can be availed of.

The plan of this work was to give a depth of 5 feet at low water, and was adopted by a board of engineers, after duly considering the possibilities of the navigation of the Mississippi River above and below Des Moines Rapids.

In view of the facts set forth above and in the inclosed report of Captain Stickney, I would respectfully suggest that true economy would be opposed to any change in the plan of this work, at least until it shall have been satisfactorily shown that a depth of 6 feet or more, at low water, can be secured and maintained throughout that part of the river between Rock Island Rapids and Des Moines Rapids, and through the natural obstructions below Keokuk.

I remain, very respectfully, your most obedient servant,

J. N. MACOMB,
Colonel of Engineers.

Brig. Gen. A. A. HUMPHREYS,
Chief of Engineers U. S. A.

REPORT OF CAPT. AMOS STICKNEY, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Keokuk, Iowa, January 10, 1875.

COLONEL: In accordance with your directions, contained in letter of 8th December, 1874, I have had prepared estimates of cost of increasing the depth of water throughout this improvement to 6 feet in lowest-water stages of the river. The depth as at present adopted is 5 feet, and to increase it 1 foot will cost as follows, viz:

At middle lock.

480 cubic yards of masonry to take down, at $3	$1,440 00
480 cubic yards of masonry to rebuild, at $9	4,320 00
300 cubic yards of dimension-stone, at $15	4,500 00
300 barrels of cement, at $2.50	750 00
100 cubic yards of sand, at $1	100 00
3,000 cubic yards of earth-excavation, at 50 cents	1,500 00
4,000 cubic yards of rock-excavation, at $1.50	6,000 00
4 gates, rebuilt, $2,000 each	8,000 00
Bailing and draining	1,000 00
	27,610 00

At guard-lock.

250 cubic yards of masonry to take down, at $3	$750 00
250 cubic yards of masonry to rebuild, at $9	2,250 00
200 cubic yards of dimension-stone, at $15	3,000 00
200 barrels of cement, at $2.50	500 00
75 cubic yards of sand, at $1	75 00
3,000 cubic yards of rock-excavation, at $5	15,000 00
1,000 cubic yards of rock-excavation, at $1.50	1,500 00
4 gates, rebuilt, $2,000 each	8,000 00
Bailing and draining	1,000 00
	32,075 00

Total cost at middle lock	$27,610 00
Total cost at guard-lock	32,075 00

Prism of canal from guard to middle lock.

150,000 cubic yards rock-excavation, at $2.50	$375
10,000 cubic yards earth-excavation, at 50 cents	5

Channels at entrance to canal.

22,700 cubic yards rock-excavation, at $4	90

Channel at Montrose chain.

42,000 cubic yards rock-excavation, at $8	336
	866
Add 10 per cent. for contingencies	86
Total cost of increase of 1 foot in depth	953
The work has already cost, up to the present time, and including the appropriation of June 23, 1874	$3,571,
Amount estimated to complete it	480
Total cost, according to present plans	4,051,
Increased cost for 1 foot additional depth	953,

I confidently expect to bring this work to such a state of completion by the 1875 as to allow of the passage of steamboats; if, however, the plan is so chan to require the additional foot in depth, the completion of the work will be dela least two years.

Very respectfully, your obedient servant,

AMOS STICKNEY
Captain of Engineers, Brt. M

Col. J. N. MACOMB,
Corps of Engineers, U. S. A.

C C 4.

PART OF THIRD SUBDIVISION OF MISSISSIPPI TRANSPORTATION-R

REPORT OF COL. JAMES H. SIMPSON, CORPS OF ENGINEERS

ENGINEER OFFICE, UNITED STATES ARMY,
Saint Louis, Mo., January 20, 18

GENERAL: In accordance with your letters of June 29 and Ju 1874, requiring me to survey that portion of the Mississippi River between the mouth of the Illinois River and the mouth of the River, under the act of Congress approved June 23, 1874, containi appropriation for surveys and estimates for the improvements re mended by the Senate Committee on Transportation-Routes to the board, &c., and to submit for approval a project for the improveme the river between the points mentioned, I have the honor to presen maps herewith and the following

REPORT.

The Mississippi River, between the Illinois and Ohio, is divide natural characteristics into three sections.

The first, extending from the Illinois to the Missouri, a distan twenty-four and a half miles, is distinguished from the other sectio comparatively clear water, discolored by earthy and vegetable m but not sufficiently charged to afford a sediment when the river is l

the mean stage, so long as the water is in motion; becoming turbid as the river rises, sand, clays, and fine gravel are borne along in considerable quantities; the alluvial banks are eroded, and this portion of the river becomes assimilated to the section below the Missouri when that section is below the mean and approaching the low stage.

The average slope of this section at low water is 0.440 foot per mile, and the current strong. The slope and current depend very much on the relative stages of the Upper Mississippi and the Missouri Rivers, increasing or diminishing as the relative volume of the Mississippi increases or diminishes.

From the mouth of the Illinois to Alton, a distance of sixteen and a half miles, the eastern shore of the river is a rock bluff rising to a height of from 75 to 150 feet, except where broken by ravines and the narrow valleys of unimportant creeks. On the west the bank is continuously alluvial, and the bottom-lands are common to the Mississippi and Missouri Rivers, here separated by a neck of land from two to four miles in width.

The second section extends from the mouth of the Missouri to Commerce, a distance of one hundred and sixty-two miles. This section derives its distinguishing features from the Missouri; turbid waters, shifting bars, and channels, rapid erosions of alluvial banks, and extensive accretions, building up and removing islands, tow-heads, and battures, with great rapidity.

Seen at the higher stages, the crumbling banks falling in masses, the spoil of the forests covering the surface, and the boiling, swirling current show the power to be encountered; and seen at low water, the wide wastes of sand bars, bristling with snags and drifts of every size and shape, with here and there the dismembered skeletons of man's work, memorials of disaster, as forcibly suggest that to undertake the control of the forces here developed is no light task.

From the mouth of the Missouri to Saint Louis, a distance of fifteen miles, the river does not touch the bluff on either side. A prolongation of the rock-formation of the west side is exposed at the chain of rocks, where a ledge extends about one-third of the distance across the riverbed. The rock probably underlies the alluvium on the Missouri side, at no great depth, for a considerable distance below the chain. With these exceptions—and the latter is not positively proven—there is nothing to check erosion on either side of the river from the mouth of the Missouri to Saint Louis.

Below Saint Louis the river follows the Missouri bluff closely for fifty-five miles, the only exception being at Rush Tower Bend, where a former island has become connected with the Missouri shore. Above Saint Genevieve the river leaves the bluff, returning to it near Saint Mary's. Below Saint Mary's it trends to the eastward, meeting the Illinois bluff at the mouth of the Kaskaskia, and follows this bluff to Liberty, whence it again is turned toward Missouri, reaching the bluffs at Big Eddy, and follows close at their foot to Cape Cinq' Homme.

Here the valley is at its narrowest, and rock appears on both sides. The main Illinois bluff recedes from the river near Liverpool, and the river continues along the Missouri bluff. A few miles below, the isolated bluffs near Grand Tower are found, on the Illinois side. Low grounds to the eastward of these isolated islands of rock indicate that the river once flowed to the eastward of them, and that the opening through which the river now flows is the result of some unknown operation of nature.

Below Grand Tower the river follows the Missouri bluffs closely for a

long distance, receding from them near Bainbridge, touching again at Cape Girardeau. Here the main Missouri bluff recedes from the river, and appears no more. A short distance below Cape Girardeau a depression allows the Mississippi waters in floods to escape into the swamps, and thence into the Saint Francis. Bluffs again appear on both sides of the river at Cape La Croix, continuing for several miles, and terminating at Commerce, but the bluff on the west is isolated, and apparently has been detached from the Illinois highlands.

Near Commerce the bluffs recede, and the valley expands into the great alluvial basin of the Lower Mississippi.

Throughout the second section the river is, as a rule, held in on one side by rocky bluffs, and is remarkably direct in its general course; only when it leaves the bluffs, as noted, does it work out the long, sweeping curves to be expected in great rivers.

Below the junction of the Missouri and Mississippi the waters of the two rivers flow for many miles side by side with a distinct line of division. As far down as Carondelet, muddy water from the Missouri may be dipped on one side of a boat, and the comparatively clear water of the Upper Mississippi from the other. Long after the line of division is lost to the eye, the difference in the water obtained from different sides of the stream is strongly marked.

The river receives in this section two tributaries of considerable size, the Meramec from Missouri, and the Kaskasia from Illinois. But their contributions to the volume are too small at low stages to have much practical influence upon the navigation, and but little upon the improvement of that navigation. The contributions of sediment, though considerable at times, are usually so small, compared with the immense quantities brought in by the Missouri, and excavated by the river itself from its banks and bed, that its effect is not discoverable.

The valley throughout this section, except near Grand Tower and at the Grand Chain, is from three to eight miles in width. Nearly the whole of this area is subject to overflow in time of floods. The ground generally slopes back from the river to the sloughs and lagoons with which the bottom is interspersed; and, as in like manner the ground slopes from the farther bank of the slough or lagoon, the probability that these lagoons have at some time been channels carrying large volumes of water is established. Many think it proves them to be sites of old beds of the river, a conclusion which is possible but not necessary, since any considerable volume of water, escaping over the banks of a minor channel, would explain the terraced formation which characterizes these river-bottoms.

The third section extending from Commerce to the mouth of the Ohio, a distance of thirty-seven and a half miles, derives its distinguishing characteristics from the entrance into the alluvial region, where the uniform texture of the soil allows the river to shape its course without restriction; and, secondly, from the influence of the Ohio.

The times of flood of the Ohio and Mississippi are very different; and as the Ohio alone is able to cause a rise to a stage 40 feet above low water, when the Mississippi is comparatively low, the phenomena of back-water are of frequent occurrence, and its ordinary influence extends as far as Commerce, frequently farther. When the Ohio is high and the Mississippi low, the current through this section is slack, but when the conditions are reversed the current becomes very rapid. Owing, in a great measure, to these excessive changes of velocity, the channel is very unstable and the erosions extensive, as also the accretions.

The foregoing are the principal distinctive feature of the sections as they present themselves to the eye.

It must not be understood that the description above refers to the navigable channel, when the river is spoken of as following the bluffs, or in stating that the course of the river is remarkably direct. The bed of the river is so broad that the channel meanders from side to side within the bed just as the bed itself meanders in the valley from bluff to bluff, and as by erosions and deposits the bed of the river, in long periods of time, traverses the valley, so the channel traverses the bed from bank to bank, justifying the remark often heard, that "not a square rod of the bed could be pointed out that had not, at some time, been covered by the track of steamboats."

The movement of the bed is ordinarily so slow that the impression to a casual observer would be that, as a general rule, the changes of the river were comparatively slight and of no great importance, as they do not, within short periods, so completely alter the contour of the bends and reaches as to attract notice. Local observers, on the other hand, noting the disappearance of landmarks, realize that the changes are great, and, keeping no exact record, naturally take an exaggerated idea of the extent and rapidity of the changes.

The shifting of the navigable channel is continual, sometimes in progressive movement; often in sudden leaps; the water forsaking one course and cutting out a new channel, in a very different direction, with very little warning.

The unstable character of the bars and channels renders it impracticable to execute surveys and maps giving in detail the hydrography of the river or the exact form of the bars. If, by elaborate survey, these features were determined, by the time the maps could be executed the changes would be so great as to render them useless for any practical purpose. For this reason maps, descriptions, and plans relating to the Mississippi must of necessity be confined to general features; details would tend to confuse and deceive rather than assist in comprehending the real character of the river, and the mode of dealing with it practically.

The surveys executed under the act of Congress of June 23, 1874, furnished only part of the material for the construction of the maps submitted herewith, and could not do more because of the limited amount of the appropriation. The map from Alton to the mouth of the Meramec is constructed from surveys made in 1870, 1871, and 1872, and does not show the present river as faithfully as could be desired. Very important changes have taken place at and below the mouth of the Missouri since these surveys were made. Below the Meramec, the shore-lines, at all points where improvements are desirable, were determined by actual survey during the season of 1874. At such parts of the river as are now unobstructed by bars, the shores are taken from the best data of former surveys, corrected by reference to the points established by the triangulation made in 1873 and 1874. Although not strictly accurate in matters of detail, the fixed triangulation-points forbid errors of sufficient importance to vitiate any conclusions that will be drawn from these maps. The small scale of the maps submitted, and the fleeting character of hydrographic features in a silt-bearing river, prevent any attempt to show soundings. A dotted line shows in important localities the channel as it existed at the time the surveys were made, and does not profess to show the channel during the season, nor as it existed at any specified date for the whole length of river shown. A considerable portion of the survey was made when the water was at the mean stage,

another part at a stage approaching low water, but none at extreme low water. Consequently it must be borne in mind that the channel marked out is more direct than a low-water channel.

Detail-maps of the several localities have been prepared for special studies of localities.

The surveys already executed afford much valuable information as to what the tendencies of the river are, but do not give any information as to what has been or what will be. It is essential that a continuous series of surveys should be made henceforth, as long as the improvement of the river is incomplete; and it is to be regretted that no surveys were made previous to 1873 which can be made available in the study of the physics and hydraulics of this portion of the Mississippi. Regretting the omission of the collection of data in the past, the neglect of observations and full records now would be inexcusable.

The value of the triangulation lately made in fixing points of reference, by whose aid each special survey can be located in its proper place and relations, and the exact changes of the river indisputably determined, has been very great. The necessity for a triangulation, including the whole valley from bluff to bluff, at an early date, is apparent, to secure and verify the position of points along the river, the greater part of which are liable to destruction.

In addition to surveys, as ordinarily understood, full records of observations of stage should be kept, frequent measurements of the discharge made, especially at the extreme stages, and special investigations of the movement of silt, in bodies and in suspension.

Discharge-measurements were made during 1873 and 1874 whenever the surveying-party should find a suitable place and opportunity to take the necessary observations without too great sacrifice of other duties. The series is short, and observations were never taken twice in the same locality; consequently the results must not be considered final nor the conclusions indicated as anything more than approximations.

Table of approximate discharges, &c.

Number.	Localities.	Elevation of water above low water.	Date of observation.	Sectional area.	Width.	Mean depth.	Mean mid-depth velocity per second.	Discharge.	Remarks.
		Feet.		*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Cu. feet.*	
1	Below foot of Carroll's Island.	21.8	May 17, 1873	73,664	2,500	29.4	5.005	368,747	
2	Brickey's mill	19.6	July 23 and 24, 1873.	54,152	1,850	20.9	5.209	282,108	
3	One mile above mouth of Ohio River.	14.54	July 13, 1874	39,508	2,425	16.3	5.13	202,524	River rising 0.2 ft. in 24 hours.
4	Philadelphia Point...	11.75	June 5 and 6, 1874.	42,187	3,740	11.2	3.51	148,103	River falling 0.5 ft. in 24 hours.
5	Three-quarters mile above Chester.	10.25	Aug. 23, 1873	26,912	1,740	15.5	3.69	99,312	River falling 0.18 ft. in 24 hours.
6	Near foot of Arsenal Island.	6.0	Dec. 4 and 5, 1874.	26,281	2,500	10.5	2.80	73,487	River falling 0.25 ft. in 24 hours.
7	Cape Girardeau......	6.9	Oct. 23 and 24, 1873.	20,756	1,730	12.0	3.44	71,413	River falling 0.2 ft. in 24 hours.

None of these measurements affording an extreme low-water discharge between the mouths of the Ohio and Missouri Rivers, we are compelled to deduce it approximately from the observations made at compara-

tively low stages. Referring to the table and comparing the two observations numbered 6 and 7, when the stages of water were, respectively, 6 feet and 6.9 feet above low water, it will be observed that the amount of the first was 72,487 cubic feet, and that of the latter 71,413 cubic feet, the former exceeding the latter by 1,074 cubic feet, although taken apparently at a lower stage of water.

Accepting these results as approximately correct, they suggest the fact that the bottom rises and falls to a certain extent as well as the water-surface; hence, it is not possible, having a true cross-section at one stage of water, and knowing the velocities at much lower stages, to obtain a discharge for those stages by making the proper reduction in depth and corresponding reduction of sectional area; for the area may be lessened by deposits or increased by the scour during the interval.

Now, if a section of river could be found having an unchanging bottom, by the proper reduction of cross-section to the low-water stage, we might be able to obtain an approximate discharge for extreme low water. This condition is approximately fulfilled at the Chester section, where the bed of the channel proper is solid rock. The proper reduction being made, the sectional area becomes 14,986 square feet.

The velocity at this section for a low-water discharge is arrived at in the following manner:

Comparison of the stages of water when the Cape Girardeau and Chester discharges were taken, shows that there is an apparent difference of elevation of 3.35 feet. The Chester section reduced to this stage gives a sectional area of 21,805 square feet. Comparing this area with that obtained at Cape Girardeau, by observation it was found to be 1,049 square feet in excess. Now, since this area obtained by reduction is greater than that obtained by observation, the velocity must be less at Chester than at Cape Girardeau. Dividing the discharge obtained by observation by the sectional area obtained by reduction, we obtain for a velocity at this stage (6.9 above low water) 3.28 feet per second. Assuming that this velocity continues to diminish in the same ratio $\frac{(V-V')\ (d'-d'')}{d-d'}=V'-V''$ to a low-water stage, we obtain 2.44 feet per second as the velocity for a low-water discharge at the Chester section.

We now have the probable low-water area, 14,986 square feet; and the probable low-water velocity, 2.44 feet per second; their product, 36,565 cubic feet, is the probable low-water discharge. We can now assume any mean depth of water as a minimum; 10 feet would probably be most desirable. By using this depth (or any other desired) and the low-water discharge as constants, we can ascertain the proper width of water-way at different localities where different velocities exist.

The following table is presented as an application of this:

Discharge ÷	velocity. =	sectional area ÷	mean depth =	width water-way.
36,565	2 feet per second.	18,282	10 feet.	1,828 feet.
36,565	3 feet per second.	12,188	10 feet.	1,218 feet.
36,565	4 feet per second.	9,141	10 feet.	914 feet.

The fallacy in the reasoning by which the above conclusion is reached lies chiefly in the assumption that a stage of 6.9 feet above low water at one point corresponds to the same stage at a point seventy miles dis-

tant. The exact low-water reference being unknown as yet at the localities where these discharges were taken, the conclusions reached are far from satisfactory, but are the best approximations now available.

No observations having been made during an extreme high-water stage, no data exist for determining the proper width between outer levees; therefore no attempt can be made to determine this until more extensive observations have been made bearing on the subject.

From such observations as are on record, it is believed that at a bank-full stage, about 25 feet above low water, 3,500 feet is the proper approximate width.

The unstable character of the Mississippi has its origin in the rapidity of the currents, the excessive variations of volume, and in the loose texture of the soil through which the river works its way. Since none of these causes of instability can be changed or modified essentially, it is necessary to accept this character as an absolute condition, and study its phenomena, in order to gain acquaintance with the laws or generalized facts, and thus be able to obtain the assistance of nature's forces, rather than contend against them.

Soundings, taken at various times and localities, prove conclusively that the depth of water in the river does not follow the rise and fall of the surface as given by gauge-readings. While one would not be justified in asserting it as a fact universally, it is abundantly proven that the bars, at least, rise and fall with the water to a degree that can best be expressed in the statement that a wave of sand accompanies the wave of water in a rise, but moving at a slower rate.

If a cross-section of the river be taken during high water, the soundings, reduced by the known height of the surface above low water, will become zero, or even a minus quantity in many sections, and always much smaller than the depth known to exist at the same locality at low stages.

Again, comparing the depth at various low stages upon the same bar, it will be found that the depth upon the bar does not increase or diminish in the same ratio as the water rises or falls, but, contrary to what would be expected, the depth often increases as the river falls, and diminishes as the water rises on the gauge. In the language of boatmen, the bars "cut out" in a falling and "flatten out" in a rising river.

Since we know that, at ordinary high waters, the low-water channels are completely filled with sand, or very nearly so, the question is suggested whether in great floods the same is not true in a greater degree; in other words, whether a considerable part of the ordinary river-bed is not occupied by sand instead of water? If this be so—and facts, so far as observed, indicate that it is—the height reached by floods depends upon the amount of sand accumulated in the bed as much as upon the volume of water passing; and, moreover, it becomes probable that the influence of tributaries, in raising the river, often exceeds the ratio of the volume of water they contribute. As they come in at times very highly charged with sediment, especially the Missouri, a portion of this sediment is deposited, occupying and obstructing the water-way. The remainder, borne along mingled with the waters, and thus diminishing their fluidity, and therefore the velocity of the flow, also assists in the heaping up of the waters.

At first thought the discussion of flood-phenomena may not seem pertinent to the subject of improving the channel. Since navigation is not impeded at floods, many hold to the opinion that, so far as navigation is

concerned, the river at its higher stages may be left to itself, and that practical operations for improvement should be limited to the low-water bed, and look only to deepening the water over the bars.

But if the sand-wave fills the ordinary bed at times of flood to any great extent, there is reason to apprehend that an entirely new channel may be made, flanking the works of improvement, and disturbing the channel above and below for considerable distances. Moreover, there must always be a period, during the decline from a flood-stage, when the channel maintained by the flood must change, to adapt itself to the diminished volume; for the floods, following the straightest cuts and along the shortest lines, convey the heavier and harder materials with them. The low-water volume, small in quantity and possessing less power, generally works its way through the softer portions of the bed along the bends, &c.

The shifting of the channel, due to the varying volume of water, is a fact observable in all rivers, and the Mississippi differs only in that the changes are more radical. During the transition period, the channel must be uncertain and comparatively shoal; and the only remedy is to control the flow at all stages, at least to the extent of keeping the permanent low-water channel within the width of the channel at ordinary high water. As the high-water channel is always much wider than the low, this would seem to be practicable, the main difficulty arising from the fact that the low-water channel is much more tortuous than the high.

Considered as to hydrography and the direction of the currents, the Mississippi, when low, is not the same river as when high, and obviously the problem of a permanent and complete improvement involves the reconciliation of these diversities.

The bars in the Mississippi are chiefly composed of movable sand, and travel down stream at a rate in proportion to the velocity of the current, changing their shape as they pass the bends of the river or meet with obstructions that lessen the velocity, or deflect the current from its natural direction.

These bars overlap each other so that a longitudinal section of the river-bed would show inequalities similar to the surface of a shingle roof, as shown by the full lines in Fig. 1.

The dotted line shows the changes that are constantly taking place in the surface of the bars. The material from *a a a* is deposited in the dead angle *b b b*, the bars preserving substantially their shape, but traveling down stream. A plan of sand-bars upon a perfectly straight reach of river, which presents a cross-section approximating the trapezoidal form, the crest of the bar being the highest about midway between banks, is shown in Fig. 2.

Of course we do not find this regularity in all parts of the river. In fact, if it were possible to make the river perfectly straight, it would not long remain so, unless the banks were protected from erosion.

We usually find reaches, which are straight in general direction, broken up into very short curves and approaching the form presented at well-defined curves, as shown in Fig. 3.

The introduction of any foreign substances, such as snags, drift-piles, &c., will change materially the shape and movement of the bars; so also will the curves of the banks. When the river rises the movement of the bars is more rapid, and as the bottom of the river also rises and falls again with the water, a channel is then formed in a new place as the water recedes, the crest of the bar giving way at its lowest point, which is usually nearest the shore, generally leaving a pool of water

below each bar, and the low-water channel winding from side to side under the crests of the bars and through the pools.

Fig. 1.

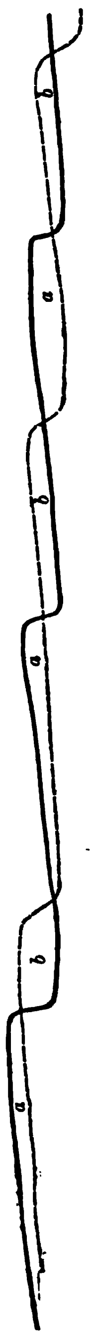


Fig. 2.

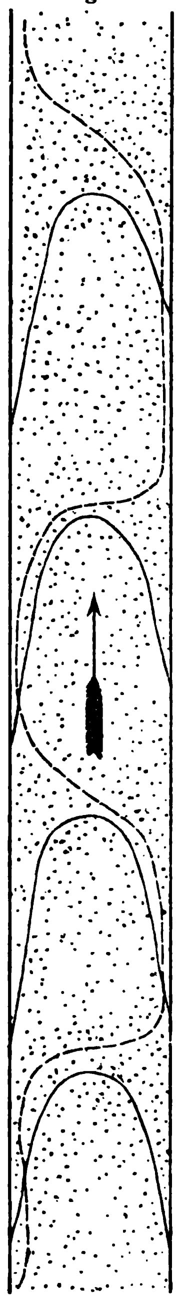
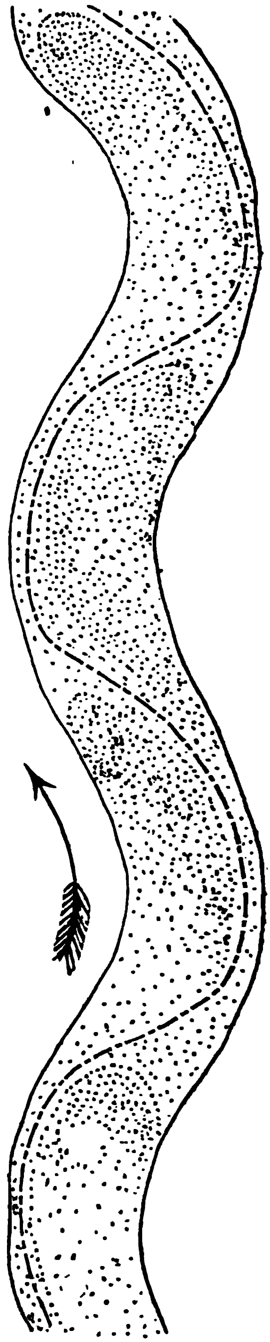


Fig. 3.



The foregoing is given as a generalized statement of the form of the bars, and suggests that the position of the bars is determined by the outline of the banks. The frequent apparent exceptions found in the Mississippi are reconcilable by keeping in mind a distinction between the banks of the low-water river and those of the river at high stages. The dry bars form secondary banks at low stages, and to these banks the extreme low-water channels conform.

It is a fact well known that in the case of rivers flowing through alluvion the channel follows a succession of curves, convex connecting with concave, and that the deepest water generally follows the concave bank. The steamboat crossings are along diagonal lines, running from near the lowest point of one concavity to a point above the apex of its alternate opposite concavity.

From some observations made upon the Garonne, the point of deepest water in a bend was found to be several hundred feet below the apex of the curve, and the shoalest water along a convexity, at about the same distance below its apex; even where bounded by rocky banks, this effort at curvatures is apparent. Two instances of it may be pointed out, viz: at Cape Cinq Hommè, where the right-hand bluff above the point is slightly concave toward the river. The channel, following this bluff closely, makes, after passing the point, a reverse curve of considerably smaller radius, evidently limited to this degree by the rocky Fountain Bluff. At Cape La Croix the case is still analogous, though the channel curves sharply round the point and straightens down to the Grand Chain.

Even in rivers flowing through alluvial beds, the apparent anomaly of the channel being found directly under the point occasionally obtains, and can be explained by the fact that the velocity carries the gravel and other hard materials past the point, the inertia of the moving mass being so great as to keep it in its direct path until arrested by the opposite shore.

The channel through the section between Commerce and the mouth of the Ohio is subject to greater variations than the other sections because the soil is more uniformly alluvial, and the variations of velocity very great. As already stated, the current is slack when the Ohio is relatively higher than the Mississippi; at such times much of the sediment brought to this section must necessarily be deposited by the comparatively still water; to be removed in whole or in part when, the conditions being reversed, the current through this section becomes more rapid than at any other part of the river. The changes consequent upon these variations of velocity differ in degree only from those occurring in other sections, and will require greater care and expense, in any works for its improvement, than elsewhere, but there is no reason to doubt that success can be assured in the application of the same general system.

The banks of alluvion in all the sections are light and movable, with strata of quicksand underlying or outcropping in many places. These banks are constantly changing from the action of the current upon them. In addition, the water, when high, saturates the bank, while, at the same time, it aids in supporting it. As the water falls, the saturated earth, under its increased weight, and its tenacity lessened by saturation, falls off in large masses, and is taken up by the current. The quicksand, semi-fluid as it is, when it moves laterally, removes the support of the superincumbent mass, another cause of slides.

Another patent cause of action upon the banks comes from the waves of passing steamers, and their action has been found energetic enough

to affect the bank, even when revetted with stone, the wave action being propagated through the interstices of the revetment-stone.

At what depth the bed-rock underlies the sand, gravel, &c., of the river is only known for a few places where borings have been made. But the question cannot have much practical bearing, since the depth to the rock is usually so great as to forbid the idea of seeking rock-foundations.

The transportation of sediment by running water is a topic that has been often discussed, and many theories advanced to explain the facts. The discrepancies of the theories even now held by different writers is proof that the facts have not been collected and studied to a degree justifying any statement being put forward as absolute truth.

It is recognized that the power to abrade and transport is related to the velocity; also to the character of material. Besides these obvious elements there are others—continuity and change of direction and depth—which have an undoubted influence; but the relative power of each element in producing the result is wholly undetermined; nor is it certainly known whether all the elements have been discovered.

A shade of the truth probably pervades all the theories, but mixed with much error, arising from their having been based upon the study of a single stream, and that presenting probably extreme conditions. From France comes the theory of the controlling influence of breaks in the continuity of the direction or in the changes of direction; from India, the theory that water, flowing between banks or over beds of loose material, carries a load of sediment, bearing a fixed ratio to the velocity, subject to modifications by depth, and, of course, the character of the material carried. Briefly stated, in a river flowing in a bed whose material is uniform, the amount of sediment borne varies directly as the velocity and inversely as the depth; and that the water passing any section is always charged with the full amount of matter which it is capable of carrying. Consequently, the load borne varies with every change of velocity, however slight; dropping a portion of the load when velocity is diminished from any cause, producing sand-bars, and recovering its load by attack on the bottom or banks when the velocity increases resulting in erosions; while with a uniform velocity, neither erosion nor deposit can take place. According to this theory, uniform motion, with its attendant saturation with sediment, should be the object.

According to the impact and friction or change of direction theory, deposits are inevitable if sediment is borne, and erosions must occur if the angle of impact exceeds a limit proportioned to the resisting power of the soil; consequently, according to this theory, the object is to diminish the amount of material in motion, to prevent deposits, and to check erosions by protecting the banks exposed to attack, and to prevent the occasion for injurious action by securing an unbroken continuity to direction, and reduction of the angle of impact by regulating the outline of banks to a succession of osculating curves.

Experience has shown that practice under the latter theory is attended with success. The former theory rests upon observations, but has not been tested by practical works for the improvement of rivers based upon the principles given. One prominent fact observable on the Mississippi is contradictory of the practical part of the equilibrium or India theory, for, as has already been stated, the waters of the Mississippi and Missouri Rivers flow side by side for many miles, with a distinct line of division between clear and muddy waters. Where the waters of these rivers first come in contact, the clear water of the Mississippi is pressed

against the alluvial bank on the Illinois side, which it cuts into rapidly, and in the clear part of the river is found the deepest water and most rapid current. Passing into Sawyer Bend, on the Missouri side, the Missouri water comes in contact with a bank similar to that previously pressed by the Mississippi waters, and, although thick with sediment, the erosion at this place fully equals that above; continuing past the city of Saint Louis, the water comes to the bridge with the line of division yet distinct, and immediately below the clear Mississippi water presses upon a bar upon the Illinois side without any remarkable attack. Thus it may be traced until the difference in the waters fades out, but without developing anywhere the marked erosions of the Illinois bank, or the alternative extensive deposits on the Missouri side which the theory would demand; for, according to it, it should be impossible for two neighboring fillets of water to flow over the same bed, and with equal velocities, without carrying an equal load. The case has been traced so far that each kind of water has undergone both increase and diminution of velocity, and many changes of depth and direction.

Many facts are required to establish a theory; one, if unreconciled, can disprove it. When the attention of the author of this theory was called to the fact here presented, he replied:

> * * * In the examples of the large American rivers you refer to, where the Missouri brings down water quite turbid, while the Mississippi is nearly a clear stream, I would observe that, where the load of solid matter held in suspension is not probably the one-thousandth part of the weight of the water flowing down, it may be practically impossible to observe any retarding of the velocity on account of the load transported; but with such torrents as above described,* bringing down a large percentage of solid matter, and with water loaded with sewage, I believe it is possible by experiment to discover a difference in the velocities, as compared with pure water with the same slope and transverse section.
>
> The examples above given of water flowing at great velocities, pitching about bowlders, show that a certain power must be exerted which offers some resistance to the flow of the water, and if so with rocks or bowlders forced to bound forward, so with shingle, sand, or the finest particles of clay will the flow of every stream be somewhat retarded in some proportion, due to the quantity and quality of the load transported. In the case of the Missouri River, I believe that it will be found that the rock and soil of which its catchment basin consists is composed of materials that have already undergone the abrasion of water, while that of the Mississippi will be found more crystalline, and sand will predominate instead of mud. In proof of the power of flowing water picking up its load, I may here state that in the cold season the water is quite clear, and a rupee can be seen at depths exceeding 10 feet at the head of the Ganges Canal; at the sixth mile the rupee is lost sight of at 5 feet below the surface; at the twelfth mile, about 4 feet; at 3 feet depth the rupee can be seen some twenty miles down the canal; and so on did the muddiness of the water go on increasing till about the fortieth mile, when a saturated load of solid matter was attained. It was therefore in these first forty miles that all serious action on the canal bed and banks took place prior to the time I held up the surface of the water at the falls; and in my report of November, 1861, I estimated the cutting that had then taken place in the first forty miles at some eighty or ninety millions of cubic feet of earth. It was by observing this cutting in the upper portions of the canal, and the tendency of the stream to change its channel lower down, which led me to think of this abrading and transporting power of water; and it was my native foreman, Sahib Sing, who first drew my attention to the fact that this abrading action on the bed only took place when the water admitted into the canal was comparatively clear, and not when the Ganges was in flood, passing down turbid water, which can only be compared to pea-soup, for nearly six months in the year.

The writer of the above, in dwelling upon the turbidness of the water in question, seems to have lost sight of the fact, or at least does not seem to attach much importance to it, that large quantities of matter may be held in solution, the capacity for which varies with different soils; also, of the fact that the capacity of a stream to abrade is mainly due to its living force, (M V^2,) a function of its mass and velocity; and

*Certain mountain-torrents in India, here referred to.

that the factors may change and the product remain the same. resistance to abrasion depends upon the nature and shape of the b and bottom. The matter becomes complicated when taken up in shape; and while Mr. Login's statement of facts is entitled to full res and belief for the locality to which he refers, it does not follow, by means, that the theory is applicable to the Mississippi River.

In the first part of the foregoing extract Mr. Login is defending proposition that the transportation of sediment, being work, must the expense of force, and, in the case of running water, gravity b the moving force, its expenditure must diminish the velocity. Whe this be accepted, or the view taken that mixture of foreign m diminishes the fluidity of the water, is practically immaterial; velocity would be less in either case than for pure water, though, a says, the effect would be inappreciable except in extreme cases. proportion of sediment in this part of the Mississippi River under cussion has been stated, in a report made to the public-school boa Saint Louis, to be $\frac{1}{3226}$ part in volume. Noting that Mr. Login li the sediment-saturated waters he observed to pea-soup, and remem ing that his idea of pea-soup is English, it is evident that the wate the Mississippi do not approach such saturation; consequently, theory does not apply practically to the Mississippi.

Mr. Login's observations show that the point of saturation is s times reached; and he does not assert that water flowing over an u ble soil is always so saturated; rather the contrary; for he says th required the active erosion for a distance of forty miles in the Ga Canal before the point of saturation was reached. The violent unwarranted assumption that a given current is always charged the full load of solid matter that it is able to carry has been add his statement, and is abundantly disproven.

Passing from theory to the practical question of securing the o definitely placed before us by the order of Congress requiring this su to be made, which was to obtain plans and estimates for the improve of the Mississippi, so as to secure a navigation affording a depth least 6 feet, at the lowest stages of water, from the mouth of the Ill to Saint Louis, and 8 feet from Saint Louis to the mouth of the Ohio first inquiry is concerning the character of the navigation desired. S the requirement specifies the lowest stages of water, it must be u stood that the same or a greater depth is expected at all stages a the lowest. The lowest stage known does not occur when navigati practicable in the section of river under consideration, being a c quence of ice-gorges above the point of observation, acting as da cutting off for a time the supply of water to the river below, w therefore, drains out. Such abnormal occurrences cannot be prov against.

Taking the lowest stage to mean the lowest occurring when navig is not suspended by the rigor of the season, the obtaining of the de specified at that stage does not necessarily imply the existence of or a greater depth at all higher stages; for, as has already been st the channel-depth sometimes increases as the river falls.

The depth of a river depends upon the form as well as upon the of cross-section, and a large area may, from immoderate width, a less depth than a smaller but narrower section—a consideration of importance in determining the plan of improvement.

Another requirement of improved navigation is, that it should b liable. The possibility that an improved navigation, after being a able for one or more seasons, may deteriorate, would forbid the in

ment of capital in floating stock and the other facilities requisite to the transaction of business. Commercial relations are so extended and delicate that an inferior and more costly route of transportation will be preferred to one having the advantage in these respects, but which cannot be relied on for future engagements. This quality being in some degree wanting in the Mississippi route, is one of the principal reasons why the business of transportation upon this route has not kept pace with the development of the territory it drains.

The demand, then, is, first, that a good navigation be obtained; second, that it be maintained.

The magnitude of the river and of the interests at stake, which occasion the demand for its improvement, measure, the one the task, the other the means of accomplishing it. How great these are, it is not the design here to consider; but it is assumed that they are in due proportion, and that the only questions before an engineer are, what can be done, the plan of operations, and the mode of conducting these operations.

The first demand, that a good navigation be obtained, is satisfied with depth of channel. Combined with the second, that it be maintained, the continued existence of the channel is required, or the provision of ample and efficient means for its restoration, whenever impaired, so quickly, that practically no interruption shall occur. The first alternative implies permanent works; the latter may be satisfied by temporary.

Many persons, as before adverted to, hold to the opinion that attention should be confined to the amelioration of the low-water channel, as it defines itself year by year. Therefore, a consideration of the various modes of effecting a temporary benefit is necessary to a fair discussion of the subject before us.

The effort for this purpose must be directed to opening a passage through each bar as required, and as the bars, or reefs, are comparatively short in the direction of the channel, it is supposed that all that is needed is to make through the crest of the reef an opening wide enough for navigation, and that the increased strength of current will keep it open for the remainder of the low-water season. If it were possible to consider the reefs as abiding in nearly the same position throughout a season, this mode of opening a channel would be simple and apparently easy; as the appliances used, after accomplishing the end at one locality, could be moved to another, and thus, in succession, a single equipment would answer for a considerable extent of river. But as the sand reefs have a progressive motion in many cases, oblique to the line of deepest water, the channel is crowded out of its first position, and a new crest is formed, a process which can repeat itself many times in a season. This tendency, in connection with the shifting of the channel already mentioned, as attending decrease of volume, will make frequent returns of the equipment to the same locality necessary, and instead of maintaining a good navigation over a long extent, it will be found in practice, that, to be effective, an equipment would find full employment upon two or three crossings, and while an opening is being made the appliances must occupy the channel; which is a serious objection. In order that these opened passages may maintain themselves, it is necessary that the additional area obtained in the channel should be compensated by the filling, or obstructing, of an equivalent area from some other part of the cross-section, outside of the channel; otherwise, we expect the impossibility that a certain volume with unchanged or increased velocity should fill an increased area.

These remarks apply with equal pertinence to two classes of appli

ances, viz, scraping, dredging, or agitating machinery, and portable dams. Comparing the merits of these classes of devices, the advantage would be in favor of portable dams in first cost and operating expenses. Both classes have been tried, and have demonstrated their ability to open a way through a reef; but the results have not been satisfactory hitherto, because not lasting. It may be objected to this statement that the permanency of channels opened by portable dams has not been tested, as the only extended series of experiments on the plan of opening bars has been with the Long scraper; but it must be admitted that the performance of an opened channel cannot depend upon the means by which the opening was made when the means are removed from the scene. The competition between devices for this purpose is limited to cost and efficiency in opening, and it is not the purpose here to discuss the relative merits of devices, but to consider the results which may be attained by their use. Experience indicates that to maintain a channel in this way would require an equipment for each section of 10 miles, to be kept in active operation during the low-water season of each year for all time, and the results then uncertain, and a serious disadvantage attending the application of the system.

A permanent improvement must of necessity be designed and executed in entire harmony with the natural laws of the river. A mighty river is impatient under restraint; can be led, but not driven. In one sense, the difficulty of executing a plan of improvement increases much more rapidly than the size of the stream; in another sense, the potent forces, judiciously handled, can be made to do no inconsiderable part of the work.

Permanent works may be considered as serving a twofold purpose: first, to obtain and maintain a good navigable channel; second, to protect the adjacent lands from erosion and overflow. The navigation interest is without question the only one now to be considered; but the landed interest will certainly derive important incidental advantages from the permanent improvement of the channel.

The maintenance of a good navigable channel requires—

1st. Sufficient depth at all stages.

2d. A judicious location.

3d. Stability in position.

4th. Facility of approach to landings.

5th. Easy changes of direction.

6th. Moderate velocity of current.

These requirements stand above in the order of their importance. The first is a condition-precedent, and must be satisfied. In solving the problem of securing depth of water, we have to deal with certain elements, all to some degree variable, either naturally or artificially, and the combination of the whole fixes the depth at any given time and place. These elements are width, volume, and velocity; and the latter term depends upon the slope, or descent, and distance, as its controlling elements. Of the terms of this function the slope is fixed naturally, if we compare the elevations of geographical points connected by fixed lines; but if the length of the lines can be varied, then to that extent slope is an element subject to control; also, the same result may be reached by producing a different distribution of the fall. To deepen a channel by changing its slope would be equivalent to lengthening the river. (The change of distribution of fall involves its concentration by dams, a method clearly inapplicable to a large silt-bearing river.)

Volume is an element which, for periods of time, is fixed naturally; but the discharge may be distributed artificially, so as to be more nearly

uniform than the supply. The proposition to feed rivers at low stages from reservoirs filled at the higher is practicable with small streams, but for large rivers, the areas required for reservoirs and the cost of retaining-dams become so enormous as to render the proposition impracticable.

The element of width is so evidently within the range of control, that no argument is required to establish the position that contraction of widths is the easiest and most practicable mode of increasing the depth of channel in all cases where the volume is practically beyond our ability to control; in some cases, in addition to contracting width, it would be advisable to lengthen the channel. It will be seen that shortening must be avoided, as a rule; for the effect of a shortened course is to increase the slope and velocity, which would require an inordinate contraction of width to obtain the desired depth, and the increased velocity would endanger stability.

The second requirement, the judicious location of the improved channel, includes the purely engineering consideration of following the natural tendencies of the river, or at least the negative proposition, that no unnatural changes of position should be made or unstable natural conditions be accepted, and also due consideration of the convenient use of the channel for all the purposes incident to navigation and commerce.

In the consideration of this topic, we come in contact with many local and individual interests; also, with the opinions of many persons who have from observation and reflection arrived at fixed opinion concerning the course to be followed. Conflict with the former is to be avoided as far as possible. The latter may be considered, but cannot be allowed to govern. There are two opinions (held by many who glory in calling themselves practical men, and delight to cast contempt upon what they call scientific theories), which have their foundation in very poor theory, because unscientific. One is that the channel should be straightened and canalized; the other, that it should, in all cases, be held along the foot of the bluffs, where such exist. Without entering into any extended discussion here, it is proper to recognize the existence of these opinions, and state briefly why they must be rejected.

The logical objection to straightening the channel has already been given: the velocity would be increased thereby, and increased destructive energy be brought to bear upon the banks and bed. It may be said that such increase of velocity would be temporary, as the river would adapt itself to the new condition, and, in time, regain its former slope. This can only be done by regaining its original length, or by a lowering of the bed, proceeding from the lower part of the river toward the upper. But where the bed is composed of material too hard to be readily moved, the accumulated fall must produce a rapid. The cut-offs that have taken place in the Lower Mississippi have not permanently shortened its course, and many which were made in Europe, especially upon the Rhine and Danube, with the purpose of shortening the distance between points of commercial importance, have defeated that design, by creating a current which proves a serious obstacle to ascending boats; and the lowering of the level in the reaches above the cut-off develops many new obstructions, while the deposits in the pool below cause similar difficulties there. The idea of the advocates of straightening is that, with a shorter course, flood-waters will pass without entailing injury, and that the increase of current will not impede steam-navigation in a greater ratio than would be compensated by the decrease of distance.

The suggestion that the channel should be made to follow the bluff is made simply because the bluff presents an unyielding bank, against which it is supposed to be an easy task to hold the current. As the bluff-lines are very straight, this proposition is similar to the first-mentioned, and liable to the same objections. To hold the river to straight lines would be a work of great difficulty, and the difficulty would increase with increased velocity. One fear entertained by those favoring the bluff-line is, that if the channel be allowed to make a sweep out into the bottom it cannot be controlled, forgetting that it is easier to control a current following its natural course through alluvial soils than it would be to force it from that course by works which must rest on the same unstable foundation as the lighter structures required to restrain it within reasonable bounds. Another consideration, which would be fatal alike to both propositions, arises from the disturbance of existing business relations by the destruction of landings, which must result from their adoption. Moreover, if the bluff is followed, the landings would be chiefly limited to the side whose broken character forbids the expectation of much agricultural produce being raised; and, in any case, the landing would be difficult of access from the back country. In addition, the opposite alluvial side would be cut off from access to deep water almost entirely.

Existing business relations have adapted themselves to the natural course of the channel; and, in order to avoid individual claims for compensation, it will be necessary to make the improved channel follow the natural course as far as possible, on the principle that riparian rights and benefits, which have been destroyed or changed by the action of natural causes, furnish no ground of claim in equity, if the privation be rendered permanent.

Policy, then, would determine the advisability of following the existing channel in all cases, and the same course would logically follow from a train of scientific reasoning; for the law of a stream is the expression in general terms of the facts presented in nature and is necessarily abstract. To reconstruct the stream according to conditions imposed or assumed can be done successfully if we know all the facts and relations which enter into the problem. The omission of one may be fatal to success; hence all arbitrary changes are to be avoided. But nature overlooks nothing, and we may confidently assume that the position and direction of the river at any time is the resultant of all the forces, and consequently is a concrete expression of the law of the stream, which we may modify and preserve, but may not safely destroy or radically change. To accept and follow nature is, in this case, the beginning and end of science. To attempt either to straighten the river or to compel it to follow the rocky shore would be alike presumptuous.

The third requirement—stability in position—is a natural consequence of permanent improvements, and essential to the establishment of facilities for the traffic. To insure this quality, it is necessary that the velocity should be sufficient to carry the lighter material brought into the channel to a suitable place for deposit, but not great enough to cause erosion of the bank.

The fourth requirement—facility of approach to established landings—is an important consideration, and since large towns cannot follow the river in its changes, the conditions presented are often antagonistic to the natural bent of the channel; and in such cases the demand is absolute that the natural be changed. At times the conditions border upon the impossible. Take, for instance, the case of a town situated upon the convex bank of a river; it is well-nigh impossible to maintain the chan-

nel on the convex side, because unalterable natural laws forbid. If we try to contract the width to such narrow limits as to obtain a required depth on the non-channel side, which is the best, and, indeed, the only thing that can be done, we endanger not only the works themselves, but also the property, and lives even, of the people, when the waters of a mighty flood demand passage through the narrow gateway; and no safe contraction can assure the desired depth on the convex side. In this connection it may not be out of place to remark that the injudicious acts of individuals, or municipalities, may often endanger the improvements made by the general government for the benefit of the whole people to serve some local project, and that the establishment of regulations defining riparian rights and the privileges of town authorities is a subject demanding the attention of Congress. The conservancy of navigation being undeniably vested in Congress, the exercise of that power, in defining the limits of encroachment upon navigable waters, is proper and necessary.

The fifth requirement—that changes of direction should be easy—is mainly in the interest of stability, but also has a practical relation to the convenient use of the channels. A discussion of the bearing of the direction of currents in relation to the banks, if entered into, would exceed the limits of this report. The result reached would be, that the current should be parallel with the banks whenever possible, and abrupt changes of direction avoided. Practically, it would not be proposed to make many changes in the present contour of banks by active interference, but rather to secure a favorable alignment when it exists; and when it is imperfect to patiently wait for nature to work out the problem of a good line. Accurate surveys of stable bends will determine the degree of curvature most favorable. When the character of the soil does not furnish sufficient resistance, some form of artificial protection must eventually be resorted to.

During this past season particular pains were taken to survey and delineate upon maps the strongly-developed curves or bends known as Bush Tower, Saint Mary's, and Cape Girardeau, the latter being considered a good example of a curve of stable regimen. These three curves, if carefully studied by means of resurvey for several years, may develop laws, the knowledge of which will be of the greatest importance in conducting the improvements of the river.

Dufontaine, who devoted a number of years to careful study and improvement of the Rhine, expressly said, that the degree of curvature to be given to the bends on a river could only be predicated upon observation of existing curves of known stability on the same stream.

Mahan, in his work on civil engineering (edition of 1867), says:

> From observations made upon the Rhine, it is stated that elbows with a radius of curvature of nearly 3,000 yards preserve a fixed regimen; and that the banks of those which have a radius of about 1,500 yards are seldom injured if properly faced.

The fact that the natural course of a river, flowing through an alluvial bed, follows a series of direct and reverse curves, merging in o each other, is universally admitted by all engineers of study and observation, and the expediency of maintaining them in such course, where local interests of magnitude do not demand and warrant departure, is equally admitted.

A cross-section in a bend will, generally, approach in shape a right-angled triangle, the right angle at the bottom and near the concave bank. Consequently, in a bend, the width may be greatly increased beyond that admissible for straight portions of the river, yet maintaining nearly the same area of cross-section, and sufficient depth in the

channel. In bends, therefore, protection of banks is the improvement required, and, considering navigation only, the work is by no means urgent.

The sixth and last requirement, moderate velocity, has been discussed incidentally already. There are localities, especially below Commerce, where the velocity is at times excessive, but beyond possibility of being changed for the better. The condition must be accepted and met by stronger works to insure permanence.

Having in the preceding discussion shown that a system of temporary expedients would fail to secure the end, and also defined what a permanent system would accomplish, the question arises, can the superior permanent system be carried out upon such a river as the Mississippi? In answering this question we have the benefit of the experience of European engineers, who have successfully improved silt-bearing rivers traversing alluvial valleys, and subject to great variations of volume, and the Mississippi differs only in degree from some of these successful precedents. That this difference in degree does not present insuperable difficulties, is proven by actual experience in works of the character proposed, executed during the last three years upon the Mississippi, which have proved successful.

The problem, then, is solved as an engineering question; the execution is a question of time and money.

The adoption of the permanent system is but a question of time; for, as the country becomes older and more densely populated, aside from the requirements of navigation, the products of the fertile alluvial lands will be essential to the welfare of the country, and the state reasons which have led to the regulation of European rivers will demand the same for the Mississippi, and, in time, its principal tributaries also. The completion of these works will require many generations; but as the necessity is clearly foreseen, it would be inexcusable to ignore it now, since it is entirely practicable to make every step in the interests of immediate wants a step, also, toward the final end, without adding to the cost or delaying the realization of the benefit desired. Assuming that this course is to be pursued, it remains to consider the steps that come first in the system proposed, which will be the work for the years immediately before us.

In the interest of navigation the improvement of the worst bars is first demanded, and this consideration decides each year the points where work is to be done. As the worst bars now are at or very near islands, or high bars that are as effective as islands in dividing the waters, the most useful work at present is the closing of the chutes, which, we may be confident, will materially help the navigation, as the cases are rare where a serious obstruction occurs when the water all flows in a single channel. After the closing of the chutes, the contraction in width in wide reaches comes as the next step, and, when complete, good navigation is obtained, and must be maintained, by the protection of caving banks.

The closing of chutes often involves more or less conflict with local and proprietary interests, and in some cases with matters which rise into the importance of state questions.

The definition of the boundaries of States by the channel of the Mississippi gives the jurisdiction over islands to the States to which they belonged at the time the boundary was defined, as decided by the United States Supreme Court in the Wolf Island case (Missouri *vs.* Kentucky, Wallace's Reports Supreme Court United States, volume 11, pp. 395–411). Several cases are known where the present channel di-

vides the island from the State to which it belongs, and if the old channel, now but an insignificant chute, is closed, the island will be territorially annexed to a State having no jurisdiction over its soil. It will readily be seen that serious complication may arise in such cases. Such annexations are likely to occur from natural causes, and several will necessarily be made if the improvement continues, and the closing of chutes is to be determined upon engineering considerations alone.

It may not be out of place to mention here the general belief prevalent among owners of land adjacent to island chutes, that the construction of a dam across the chute or slough will insure accretions of land to their benefit.

This is true to some extent. In the case of a single dam, the accretions generally take place in the shape of a bar across the foot of the slough or chute; another in the prolongation of the island; and a deposit at the head of the chute, extending some distance above the dam, frequently neglecting, however, the immediate vicinity of the dam altogether. A high dam just above the level of ordinary sediment-bearing floods would insure more deposit; but experience on the river Rhine, where, in most cases, the object was to make land, demonstrated the fact that three or more dams were generally necessary to insure sufficient depth and extent of deposit. In the case of a single low dam it was found better to locate it at a considerable distance below the head of the chute, in order to allow as much of the gravel and other material to enter the chute as possible, not only to aid in the formation of land, but in addition to prevent the ma erial being swept into the channel.

The formation of land not being an object of present consideration, we may say that as a general rule low dams and dikes should alone be used. In general terms, none of the works erected should interfere with the free discharge at high stages, but should begin to act at some intermediate stage. This should be before the want of depth is felt, and will probably vary for different localities.

The meaning of the words "intermediate stage," in the last paragraph, requires definition. The idea is, that the dikes and dams should be of such height as to produce action upon the bed when the river is first approaching the low stage, so as to prepare the channel, in some degree, for the less powerful effect of the diminished low-water volume. Yet it must not be inferred from this that violent action upon the bed is by any means advocated.

As before stated, the path of the heavy materials of floods is generally along the most direct course. The low water, having to cut for itself a channel, seeks the line of least resistance, through the lighter and softer material, and this is one reason why the low-water channel is, in nature, more tortuous than the high.

Referring to what has been said on the subject of the partial filling of the bed at high water, and the principle universally accepted, that depth of channel is easiest secured by contracting the width, the query arises, is it not possible to retain the high-water deposits in place as the water falls over a part of the width, and thus contract the width at low water? Two modes of accomplishing this suggest themselves: first, to protect the areas which it is desired to convert into dry bars by inclosing them with barriers quickly and cheaply constructed; second, by attacking the crests of the reefs upon the line it is desired to have the low-water channel follow, and thus concentrate the scour upon that part of the bed which is to be the low-water way. In practice it might be found advisable to combine the two methods, and thus open a field for

the use of some of the devices discussed under the head of the temporary system.

If, on trial, these suggestions should be found practicable, the benefits to navigation which would follow a regulation of the river could be more quickly and cheaply attained than in any other way, for we have but to secure the areas laid dry from being washed away, and the opposite bank from caving, to render the improvement permanent. Treated in this way, the immediate and temporary improvement would be entirely consistent with the system of permanent improvement.

The mode of construction having been described in my annual report for the fiscal year ending June 30, 1873 (see Report of the Chief of Engineers, page 444 *et seq.*), it is not necessary to enter into details here, as in all essential features the plan there discussed is still followed.

Variations in the minor features, of course, must be made, as circumstances demand.

In constructing dikes and dams upon the unstable foundations found in the Mississippi, the difficulties to be encountered are the strength of the current and the liability of scour around and under the works during construction and after completion. The strength of the current is a difficulty to be overcome, and must increase with the progress of the works until they arrive at or near the surface of the water. The scour must be arrested at an early stage of the work, or the additional expense incurred of placing foundations in deep water, and of the greatly increased prism of material required to reach a determined height. Settlement of the works during construction and even after completion is to be expected.

Various modes of construction have been tried and most carefully studied, and decided preference is given to the general plan of brush foundations and riprap superstructures as adapting itself to any shape of bottom, and being able to endure settlement without injury.

Brush foundations, besides flexibility, have the merit of distributing the weight of superstructure over a considerable area, while the body of brush presents, when compacted by the superincumbent weight, small interstices for the passage of water close to the bottom. This material being found in large quantities along the river, can be obtained and handled at moderate cost.

Extended operations would soon exhaust the present supply, and it may be found advisable to encourage the growth. Under moderate appropriations, the natural production would suffice.

Material suitable for riprap is obtainable at many points along the river, insuring its procurement at very reasonable rates. It would be good policy for the government to acquire, by purchase or long lease, several quarries, to be operated under contracts or by hired labor, as may be found most desirable.

In construction the utmost rapidity of progress is essential to economy, and it has been found practicable to carry the foundations across channels and bars so rapidly that no considerable deepening took place as the work advanced, by limiting the first work entirely to putting in an apron to protect the site of the proposed work.

In closing chutes this class of work must be done when the river is at a low stage, and in any case cannot be done when drift is running.

This limits the possibility of preliminary work to the fall season, and renders any loss of the favorable season a serious disadvantage. The postponement of appropriations to the close of the session of Congress is unfortunate in that every alternate year a considerable part of the

season is consumed in preliminaries, a loss which could in a measure be avoided if the amount to be appropriated could be certainly known as early as March of each year.

As already intimated, it is not practicable to present plans in detail, owing to the great changes which must occur between the time reports are made and the commencement of work. In so extensive a field as the Mississippi from the Illinois to the Ohio the simultaneous prosecution of works at all the points where improvement is desirable is not possible under the system of yearly appropriations, but might be done if the full amount estimated were granted at once. As this course is not supposed to be possible, it is contemplated to prosecute the works in the order of their importance to navigation, selecting those places which present the most formidable obstructions for the first operations, the number undertaken each year depending upon the extent of work required at the several places and the means available.

The estimate of this report is based upon the present condition of the river. It is probable that some of the items included in the estimate will be found unnecessary, the desired end being reached naturally; others not estimated will as probably be found necessary; it is, therefore, thought best to name the aggregate sum for each locality, without specifying the items of the estimate. As the estimates are made upon the basis that certain lengths of dams and dikes will be required, and at a cost per unit taken from the actual cost of such works already constructed, the aggregate cost will probably not be materially changed by the changes in the position and length of individual proposed works.

The list of localities is not final, if we consider the probability, almost certainty, that new obstructions will be developed hereafter. The estimate given by localities may be taken as the cost of obtaining the navigation desired. To maintain that navigation will require the revetment or other protection of caving banks. The estimated sum of $4,000,000 is intended to cover the cost of such works—to preserve the channel at those points where the necessity is likely to occur.

Further examination would be necessary to determine where works of this character are most needed. The greater part, we may safely say, would be required between Commerce and the Ohio. The estimated time for the execution of the improvement of the channel is four years; the work of maintenance will never be complete.

One million dollars could be judiciously used the coming year, and the appropriation of this sum is recommended. With such an appropriation, work would be continued at Saint Louis Harbor, Horsetail Bar, Turkey and Devil's Islands, and new works commenced at Piasa Island (above Alton), Perry's Towhead, Liberty Island, Power's Island, and Greenleaf's, the bars at these localities being the ones which now most seriously obstruct the navigation.

ESTIMATE.

Locality.	Estimated cost.
From the Illinois to the Missouri River	$600,000
From the mouth of the Missouri to Saint Louis	150,000
Upper section of Saint Louis Harbor	185,000
Arsenal Island	100,000
Horsetail Bar	100,000
Twin-Hollow Bar	80,000
Platin Rock	72,000
Selma	110,000
Fort Chartres	75,000
Turkey Island	100,000
Saint Genevieve	100,000

Locality.	Estim
Liberty Island	$
Hat Island	
Grand Tower	
Hanging-Dog Island	
Moccasin Springs and vicinity	
Devil's Island and vicinity	
Hamburgh	
Commerce and vicinity	
Buffalo Island	
Greenleaf's	
	2,
Add 10 per cent. for contingencies	
Revetment between the mouth of the Missouri and mouth of the Ohio Rivers.	4,
Total estimate	7,

In the conduct of operations upon the treacherous foundations characterize the Mississippi, economy and success demand that gineer in charge should have entire liberty to modify his plans wh necessary, and to have full control over his work; to push it f when occasions demand, and to suspend when it becomes desir to do.

Contracting works of this character is attended with serious d ties: first, because all estimates are necessarily indefinite and unc under varying conditions the character of work is liable to cha the kind, proportions, and amount of material used, and what w pected to be easy may become difficult, or anticipated difficulti disappear. These contingencies render it very difficult to frame cations that will meet the practical conditions, and bids must b at a venture, which demands a wide margin in prices beyond definitely-described work can be done for. Under such conditio result of a letting, under existing regulations, is almost inevita give the award to irresponsible parties, the guarantees and bonds satisfy the requirements affording no sufficient security. Expe has shown that, with an inefficient or tricky contractor, works character are very expensive, for delay or neglect, intentional results alike in vastly-increased quantities of material; and as the contemplate the placing of foundations in water of moderate dep suspension of work for a few days will produce a local scour th ceeds the depth provided for, and compels resort to more exp methods not provided for in the contract.

Considering the matter in the light of experience, I cannot mend the contract system, so far as the preliminary work of apro foundations is concerned. After these preliminaries are secured is no objection to adopting the contract system for the delivery terial in the body of a dike or dam. Necessity has compelled provide the plant required for the construction of these advance and, working under small appropriations, this plant suffices to the work; and, it being unquestionably good policy to keep equi fully occupied, the work of the present year has been done by the States directly by hired labor, and the purchase of material in i ural state. Although compelled, by act of Congress, to pay twen per cent. advance upon prevailing rates of wages for labor, the show no increase of cost over the prices formerly paid contract material delivered in place; and all the work and workmen bein in immediate control of the engineer in charge, he is made respo for the success of his operations.

This system has been found to work well; no serious mishaps have occurred, and the work is done more cheaply than before, though, in part, this may be attributed to improvements in the methods and experience in their application. Contrary to the prevailing impression, that faithful labor cannot be obtained from men directly employed by the government, the amount of work done compares favorably with that accomplished by equal numbers working for a contractor. Faithful labor can be had under faithful overseers and foremen by any employer, and with unfaithfulness or inefficiency in the higher grades no employer can secure faithful service.

To carry on extended operations, such as are contemplated if this project meets the approval of Congress, it would not be practicable to do all the work directly by hired labor, on account of the extensive equipment that would be required at times, but which could not be fully employed at all times; besides, the burden and responsibility of making disbursements in small sums would be excessive. For the reasons stated. I would respectfully recommend that, under annual appropriations of $300,000 or less, the system now practiced, to do the work directly by hired labor, and purchase of materials in open market, including in the latter the privilege of purchasing material delivered in the work when it is to the interest of the government to do so, be continued. Under appropriations exceeding $300,000, the conduct of all critical and uncertain operations to be by hired labor, and material purchased as above; and the construction of works whose character is ascertainable to be let to contractors.

The plant required to carry out these recommendations, under yearly appropriations of $1,000,000, would consist of two tow-boats, two steam-launches, twenty barges, six pile-drivers, one Osgood dredge, and such small tools as would be required for quarrying and handling stone, and procuring other material employed. Of this plant there is now on hand, owned by the United States, one tow-boat, one steam-launch, sixteen barges, three pile-drivers, and a stock of tools proportionate to the present scale of operations.

RECAPITULATION.

I briefly recapitulate the conclusions reached by the discussion, and which are the basis of my recommendations:

1. Improvement must not only be made, but maintained.
2. Temporary expedients fail to answer the requirements, for want of reliability.
3. Permanent improvements are known to be practicable by actual experience in the case of other rivers similar in character, though of less size, and the practicability of executing permanent works in the Mississippi is demonstrated by works already constructed.
4. In an improvement the natural channel should be followed as a rule.
5. The rights of individuals and municipal or other corporations should be defined, and all proposed works subject to approval by United States authority, as in the case now with bridges.
6. The order of execution of work should be decided with a view to afford the earliest possible relief to navigation at difficult places.
7. Improvement of the channel can be best secured by bringing all the water into a single channel of moderate width; an early step would be the closure of secondary channels at islands and elsewhere; closing

chutes will raise questions of jurisdiction between States, which should be provided for at an early date.

8. A combination of the appliances designed for temporary improvement with permanent works may be practicable, giving earlier results and at less expense. Estimates, however, are made upon the basis of improving by permanent works alone.

9. The estimated cost of improving the Mississippi, so as to afford 6 feet depth in the channel from the Illinois to Saint Louis, and 8 feet from Saint Louis to the Ohio, is $3,159,200; and the estimate for such maintenance-works as can now be foreseen is $4,000,000. The improvement-division of the work can be completed in four years, and the appropriation of $1,000,000 is recommended for the first year.

10. A mixed system of conducting the work is recommended; critical and uncertain operations by the United States directly, and those whose character can be definitely ascertained in advance, by contract.

11. The removal of wrecks and snags from the channel will remain, as heretofore, an important part of the work of maintaining the channel. During the progress of the improvement the removal of many existing wrecks would be essential to success. These operations, not being under my charge, are not included in the estimate submitted, and the matter is not formally discussed in the body of my report.

Before closing, I cannot omit mentioning the great obligations I am under for the very material aid I have received in the consideration of this report from my able assistants, Capt. Charles J. Allen, Corps of Engineers, U. S. A.; Robert E. McMath, chief civil assistant; and Civil Assistants I. D. McKown, conducting the survey of the river from the mouth of the Illinois to the mouth of the Ohio River, and his assistant, Samuel H. Yonge; and D. M. Currie, Charles S. True, and S. E. McGregory, conducting the operations, respectively, at Devil's Island, Horsetail Bar, and Turkey Island, and Alton Slough, and the upper portion of Saint Louis Harbor. Every one of these gentlemen has contributed, from his intelligence, observation, and experience, to the results arrived at; and it is a matter of congratulation that all concur in the principles presented, and the plan of operations pursued and proposed.

I am also indebted to Mr. William Popp, civil assistant engineer and draughtsman, for the delineation of the maps submitted with the report.

The map accompanying this report is in four sheets—

1. Extending from the mouth of the Illinois to the mouth of the Missouri.
2. Extending from the mouth of the Missouri to Turkey Island.
3. Extending from Turkey Island to Cape Girardeau.
4. Extending from Cape Girardeau to the mouth of the Ohio.

All of which is respectfully submitted.

J. H. SIMPSON,
Col. of Eng., Bvt. Brig. Gen., U. S. A.

Brig. Gen. A. A. HUMPHREYS,
Chief of Engineers, U. S. A.

C C 5.

REPORT ON PORTION OF THE THIRD SUBDIVISION OF THE MISSISSIPPI ROUTE.

Mississippi River from Cairo to New Orleans.

REPORT OF MAJOR CHARLES R. SUTER, CORPS OF ENGINEERS.

ENGINEER OFFICE, UNITED STATES ARMY,
Saint Louis, Mo., February 18, 1875.

GENERAL: Congress, at its last session, appropriated $200,000 for surveys and estimates for the improvement of certain routes recommended by the Senate Select Committee on Transportation-Routes to the Seaboard.

Among these routes was the Mississippi River, the idea advanced by the committee for that portion of the stream between Cairo and New Orleans being to so improve it as to give from 8 to 10 feet navigable depth at all stages of water.

The duty of reporting upon this subject was assigned to me, and $10,000 was allotted to defray the expenses of the necessary examination.

As the sum was of course inadequate for the careful survey of one thousand miles of a great river like the Mississippi, it was necessary to confine the work to a mere reconnaissance, which would enable a general map of the river to be made with approximate correctness, determining at the same time the nature and extent of the existing difficulties to free navigation, together with the methods most likely to secure their removal. This plan, having been approved by the Chief of Engineers, was carried out during the summer and early winter of 1874.

An engineering party was placed on one of the government steamers and sent into the field, with instructions to sketch the river carefully from the pilot-house of the steamer, checking their work by frequent triangulations for widths, and by comparison with the best State maps attainable for lengths between known points.

The party passed four times over the portion of the river between Vicksburg and Cairo, and twice over the portion between Vicksburg and New Orleans. The work was carefully done, and is quite satisfactory. The maps show all the topographical features quite fully, giving the size and position of islands and dry sand-bars, and the location of the low-water channel at the time of the survey. The river was not low enough for a good hydraulic survey, and, moreover, there was neither time nor money enough available for the purpose; but all available information on this point was collected from pilots and residents along the river.

Although the information obtained by this reconnaissance is not sufficiently detailed or extensive to allow estimates of the cost of the improvement recommended to be made, yet it will, I hope, be sufficient to point out the nature of the improvement required, and the means by which it can be effected.

First in order is the absolute necessity of a careful survey of the whole river. We have at present really nothing definite to guide us either with regard to the present situation, or to changes which have taken place in the past. If a careful survey had been made thirty or forty years ago, it would be of inestimable value now, for the effect

likely to result from causes now at work can only be rightly inferred from the effect produced in past times by similar causes. This information we have not yet got, and hence much is left to conjecture which should be known with certainty. This state of affairs should be remedied as soon as possible, so that when in future any work may be needed on the river the data may be at hand for projecting it.

There is probably no branch of engineering which offers more practical difficulties than river hydraulics, nor is there another in which so many perplexing questions are involved, nor where so much patient observation and experiment are needed to obtain successful results.

This is mainly owing to the appalling vastness of the subject, arising from the fact that every stream, and in truth every portion of a stream, has its own special characteristics, not necessarily appearing elsewhere, which renders observers singularly liable to generalize on insufficient or erroneous data.

It is only by long and patient observation, extended over long periods of time, and covering considerable lengths of many different streams, that we may eventually hope to assign definite values to the many variables which enter the equation to be solved.

A vast amount of information on this subject may be gathered from the works of foreign writers, and of our own engineers, but this information is much scattered, and often inaccessible; it is moreover generally mixed up with many facts and features which are strictly local and hence not generally applicable.

I have therefore felt justified in endeavoring to describe here, briefly, the more striking and important features and phenomena observable on our western rivers, before discussing the special subject confided to me for investigation.

In two important features our Western rivers differ from those under improvement in the East and on the Pacific coast: first, their beds are formed of gravel, sand, or mud, instead of rock in place; secondly, they are unaffected by tides.

The nature of the beds and of the banks determines the characteristic features of all these streams, and accounts at the same time for the immense diversity everywhere observable.

Two great classes are met with.

First, we have the Mississippi north of the Ohio, which, as well as the Ohio and Missouri, all the northern and portions of each of the southern tributaries, show a well-defined valley sunk more or less below the general level of the country, and bordered by abrupt cliffs of lime or sand stone. Frequently these bluffs are partly or wholly concealed by great masses of drift, which form rolling hills and ridges extending often to the river-bank. This latter feature is especially characteristic of the Ohio and Lower Missouri, the bare, bold bluffs being principally confined to the Upper Mississippi and Missouri and their tributaries. Both features are found on the upper portions of Red, Ouachita, Arkansas, and White Rivers, together with their principal tributaries.

The width of the valley scored out of the general level varies from one to twenty miles, while its true bottom, the bed-rock, is found from sixty to a hundred feet and upward below the beds of the present streams. The bluffs themselves vary greatly in height, sometimes towering 400 or 500 feet above the level of the water.

These facts show that our present rivers are but puny representatives of their gigantic predecessors in prehistoric ages.

It is through the immense deposits of sand and gravel accumulated

by these ancient streams that our modern rivers struggle to force their way.

The banks and beds are generally sand or gravel, now pure, now mixed with alluvial matter brought down by the stream and deposited during the annual overflows. Occasionally we find the bank formed by rock-bluffs or by the drift-hills and terraces before alluded to. These banks are comparatively stable, but the others are constantly eroded by the water. The streams are therefore constantly changing their shape and direction, their lateral excursions being, however, limited by the sides of the valley through which they flow.

Secondly, in the delta region, so called, that is, on the Lower Mississippi and the lower portions of its southern tributaries, entirely different conditions are met with. The river-banks are generally found to be composed of alternate strata of sand and of very stiff blue clay, belonging to the Tertiary series. Above these strata we generally find about 30 feet of a more recent alluvial formation. The bed proper, or rather the extreme limit of scour, is formed by one of the clay layers; but, as far as the banks are concerned, there is nothing to prevent erosion taking place in any direction, and accordingly we find all these delta streams exceedingly tortuous in their courses.

On all the streams of the first class, erosion of the banks, though often rapid, is still a gradual process; the bank, as it becomes saturated, crumbles and falls into the river, a few inches at a time.

On streams of the second class, however, the process is different. The clay layers are both impermeable and insoluble, but the heavy water-pressure in floods saturates the lower sand layers to a great distance from the water's edge. As the water falls the pressure diminishes, and the water in the sand layer returns to the river, washing out the sand as it goes. The clay layers are thus undermined over large areas, and eventually the whole overhanging mass breaks off and falls or slides into the river. In this manner the rate of abrasion may become perfectly appalling under favorable conditions. Slight reflection will show that it must necessarily be worse after heavy and long-sustained floods than at other times, and observation shows this to be a fact. At low water a rapid rate of erosion may be developed by special causes, as a sharp local deflection of the current against the shore; but, generally speaking, caving of the banks is confined to high water and the stages immediately following it. On the Mississippi itself, the continual erosion of the banks gives rise to some curious phenomena, the true office and explanation of which seem not to be generally understood. I allude to the cut-offs which from time to time are formed naturally, and which are constantly brought forward by speculative individuals and advocated as a panacea for the ills resulting both from floods and low water.

In the first place it would appear, at a casual glance, that as the cutting action is greatest in the deepest recesses or apices of the bends, there would result an indefinite elongation to the right and to the left of the general direction of flow of the river, or at least it would be carried to such extent that the consequent reduction of slope would destroy both the velocity of the current and its power of transporting the mass of sediment poured into it; such would indeed be the case, although the consequent filling up of the bed would gradually raise the whole river and finally establish new conditions of equilibrium.

But in truth the remedy is far more promptly applied; the cutting of the bank is not confined to the apex of the bend, but extends along the whole concave shore, and, as the bends overlap each other, it follows

that the necks of land separating them are eroded on both sides, and hence are rapidly reduced in width.

In the course of time the dividing neck becomes so attenuated as to be no longer able to sustain the pressure of the water against it, and, as the nature of the materials of which the bank is composed allows more or less water to leak through and wash out the sand-layers, finally the whole mass crumbles, and a wide breach is formed through which the river pours with resistless force. Davis's, one of the most recent of these cut-offs, and also the largest, occurred in 1867. It cut off Palmyra Bend, eighteen miles below Vicksburg, a bend which was eighteen miles long, while the distance across the neck was only 1,200 feet. The exact slope of the river at the time is not known, but it was probably not far from 0.3 foot to the mile; therefore the difference of level on the two sides of the neck was about 5½ feet. When the river broke through, the whole of this fall had to be absorbed in the 1,200 feet of distance, making a rate of about 24 feet to the mile; and it can readily be imagined that the whole immense flood-volume of the Mississippi, flowing with the enormous velocity due to this great slope, produced very marked effects. The roaring of the waters could be heard for miles, and in the course of a few hours a channel a mile wide, certainly over a hundred and probably nearly two hundred feet in depth, had been excavated. Even then it was many weeks before the velocity of the current had sufficiently abated to allow boats to use the new channel.

It is clearly evident that in such cases as this the stream cannot long remain in a condition so different from its normal regimen; the length by which it has been shortened must be regained, so as to restore the usual slope, and this can only be effected in one way, viz, by the elongation of bends lying above and below the cut-off. This result has followed in the case mentioned, and is and must be an inevitable accompaniment of any similar occurrence. The influence of the Davis cut-off is still felt far above and below Vicksburg. The rate of erosion in the bends has been enormously increased, and to-day we are threatened with several more cut-offs between Memphis and Vicksburg. One in fact occurred during last summer, near Commerce, Miss.

After the river has once formed a new channel for itself, the old bend fills up at the head and the foot and becomes a lake. The immense number of these peculiar crescent-shaped lakes scattered through the bottom-lands on both sides of the river, shows that this action has been going on ever since the Mississippi has existed in its present state, and we would therefore seem justified in assuming that no material change has occurred, within recent times at least, affecting the slope, length, or general direction of the stream.

Such being the well-recorded effects and results of cut-offs, it certainly is surprising to find that, from time to time, their formation by artificial means has been recommended as a means of improvement, and some have actually been produced, or at least hastened, by ignorant persons. The amount of damage produced by a cut-off, particularly in those portions of the country where riparian plantations are numerous, must necessarily be enormous; and, as I have attempted to show, no good is likely to result therefrom, as the river will in time be precisely in the same condition as before.

On other streams the same phenomena occasionally obtain, but generally the mode of action is different; thus, on the Missouri, the bends being more open, a bar generally forms on the lower side of the points, while the upper side is abraded, from which action results a gradual down-stream motion of the bends, which follow each other like a series

of waves, and in this manner lateral elongation is prevented. Similar action is observable on many other streams, but not to as great or as general an extent as on the Missouri.

White, Ouachita, Red River, and other similar streams are exceedingly tortuous, but the current being generally weak and the banks tolerably firm, the amount of erosion is small; consequently these streams change but little. On the Lower Arkansas, however, where the current is rapid, the general features of the Mississippi are reproduced.

The beds of the tributary streams are composed of materials washed from the banks or brought in by tributaries, and comprise bowlders, coarse and fine gravel, sand, and mud; of these materials none heavier than coarse gravel are moved by the current; the others remain in position and form local obstructions.

The heavier deposits are more common on the Ohio River than on any other of the large streams, and that river also moves quite coarse gravel in its upper portions; lower down it transports fine gravel and coarse sand. The Upper Mississippi carries heavy sand; gravel is rare. Both these streams have clear water.

The Missouri flows over exceedingly fine sand mixed with mud; the banks are of similar composition, and the water is very muddy.

The Arkansas and Red Rivers are also exceedingly turbid, the water being tinged a bright red from the colored earths with which it is charged; the river-beds are of rather coarse sand in the lower portions; higher up we find gravel.

The other southern tributaries, White, Ouachita, &c., have clear water, and in their navigable portions transport only coarse sand.

The Lower Mississippi being the general receptacle for all these deposits, partakes of the character of all of its tributaries; the bed proper, as before stated, is clay, but superposed on this are great masses of deposits, ranging from very coarse gravel to fine mud. Its water is very turbid, having a grayish tinge, which becomes reddish after the waters of Arkansas and Red Rivers are received.

All these streams have, therefore, the common feature of generally unstable banks and beds, the water-way being usually composed of materials which the flood-current, at least, is capable of transporting.

The laws of flowing water are sufficiently well established to enable us to settle questions which arise concerning the discharge of any stream, and its dependent phenomena, so that the point specially needing investigation is the action of the stream upon its beds and banks, for to this action are mainly due those shoals, bars, &c., which are such grievous obstructions to the free navigation of our rivers.

I wish, however, to remark here that the smaller and shallower the stream, the greater will be the care needed in measuring the discharge, as in this case we are surrounded by numerous sources of error, which are of far greater proportionate importance than would be the case on large, deep streams. Also with regard to the velocity, which is generally assumed to depend mainly upon the volume of discharge and the slope. This is only the case, even approximately, on very large, deep streams. On most of the rivers that we are considering, especially during their low stages, the velocity is greatly affected by friction, and therefore varies considerably according to the character of the materials composing the bed. With similar slope and discharge, the velocity will be greatest in streams having the most unstable beds, that is, beds composed of the lightest materials, as in this case the effect of friction must evidently be at a minimum.

With regard to the slope, I wish to call attention to the grave error

of taking at its literal value the term "plane," by which the water-surface throughout the whole or a portion of the length of a stream is conventionally designated. Thus, it is customary to speak of the planes of high or low water, as though they were actually plane surfaces, which is far from being the case. In similar manner, the mean slope is spoken of and is obtained by dividing the total difference of water-level between designated points by the total length of the river between those same points.

The so-called planes of high or low water are usually established by connecting with the level a series of water-gauges. Synchronous observations on these gauges are assumed to give the shape and position of the water-surface at the time of the observations. It is thus found that the water-surface over a considerable distance is not a plane surface, but is composed of a series of plane or slightly curved surfaces, which are liable to great variations, even for the same stand by the gauge. During high water, these local variations arise from the fact that swells or freshets in the river have the section of a very much elongated wave raised above the general surface. The front and rear of the waves may make quite abrupt angles with the general surface, while the fact that several waves may be following each other, or may even be superposed, adds still more to the complexity of figure of the high-water-surface slope.

The plane of low water is even more irregular and uncertain than that of high water, for, while in the previous case we had only masses of water to deal with, in the present we have also to consider the effect produced by masses of sand and gravel.

On examining a profile of the water-surface of one of these rivers during a low or medium stage, it will be observed that the *mean slope* for the whole length differs greatly from the mean slope of any one section of, say, one hundred miles in length; and, again, the mean slope of this section will be found to differ greatly from the actual slope in different portions of the section. This complexity arises from two causes: first, the slope in the upper portion of any stream is much greater than it is lower down; and, secondly, the slope in isolated portions of the stream varies in a curious but quite uniform manner. We invariably find a series of reaches, varying in length with the size of the stream, in which the slope is very slight, often scarcely perceptible; these reaches are connected by short, abrupt inclines, on which the slope is relatively very considerable; in fact, nearly the whole slope of the stream is concentrated on these inclines. The channel-soundings, if plotted on the same profile, will show that the depth on the inclines is very much less than in the level portions, and, on comparing the profile with the plan, it will be found that the level reaches lie alternately on opposite sides of the river, and that the steep pitches occur where the channel crosses from one side of the river to the other.

These deep, level reaches, called pools, are separated from each other by masses of sand or gravel, over which the water flows as over a low dam. These masses of sand and gravel constitute the bars, and are the principal obstructions to the free navigation of these streams.

The relative depth in the pools and on the bars varies much even on the same stream; and the absolute depths are also very variable for different stages, and even for the same stage of water. In like manner, the absolute level of the pools and the difference of level between consecutive pools are very variable even for the same stage of water, and the profiles of different years may be, and generally are, quite different for the same stand by any particular gauge.

It is, therefore, evident that great care is needed in projecting any plan of improvement, lest certain local, and perhaps only temporary, conditions may have entirely altered the normal slopes of the river.

To comprehend the cause of these irregularities and their practical effect on navigation, it is necessary to consider the laws governing the movement of the large masses of sand and gravel which are set in motion and carried along by the water of the stream.

If we imagine a perfectly straight channel, with immovable bed and banks, but partly filled with sand, through which a constant stream of water flows with a velocity sufficiently great to move freely the sand below it, the effect will, of course, soon be to entirely remove the sand; if, however, the latter is supplied in sufficient quantity to compensate for that removed, our experiment will more nearly resemble cases met with in ordinary practice, at least sufficiently for what I wish to show.

Under the action of the flowing water the sand will be found to form a series of ridges, like long shallow waves, which move forward with a velocity considerably less than that of the water itself, the rear slope of these waves being very long, while the front is usually shorter and may be quite abrupt. The sand rolls up the rear slope and falls over the crest, and in this manner the wave advances. The velocity at the sides of the channel must be less than at the center, on account of the friction of the sides, and a moment's reflection will show that a greater mass of sand will be moved by the central current, and therefore that the length of the sand-wave measured on lines normal to its crest will be greatest at the center and least at the sides. Again, if the sand is not homogeneous, the heavier grains will be more readily moved by the strong current in the center of the stream than by the weaker current at the sides; hence, the heavier sand will be accumulated at the center of the wave, and the lighter materials will be found at the sides. Now, suppose the supply of water to be diminished until the decrease of velocity and scouring power render it unable to move the sand; after a short time much of the water will be drained off, leaving the sand-waves stretched across the channel like a series of dams, ponding back the water above them. The water remaining will flow over these dams in a shallow sheet, which will diminish in depth as the level above is drawn down, and by a continuance of this action a sensible difference of level between the water on the two sides of the dam is developed. When the head attains sufficient magnitude, the water will make a breach in the dam to find an outlet, the velocity due to the head attained determining the portion of the dam broken through. It evidently will not be the middle portion, because, as already explained, this must, from its composition, offer the greatest resistance; but some point to the right or left will be selected. The outflow through this breach soon draws down the level above, and, the velocity consequently diminishing, the water is no longer able to move the sand through the gap, but drops it there and the breach fills up. Another outlet will after a time be formed, but, for the reasons before given, it will be farther from the center of the wave than before, and this action will be repeated as often as there is any disturbance of the equilibrium. In any case the rule is the same; the breach is formed in the sand dam or bar as near the axial line of the stream as the composition of the bar will allow. In consequence of this action, the water no longer flows parallel to the sides of channel, for, on emerging from behind the sand-wave, it necessarily strikes the side at an angle, and it will then be deflected back, and hence the breach in the next lower pool will take place on the side

opposite the first one. The channel now will follow a series of osculating curves, whose degree of curvature will be mainly regulated by the relative amount and density of the sand and the amount of water in motion.

If now the supply of water be restored to the original standard, the channel will return nearly to its original direction; but if this operation be many times repeated, the lighter materials will, to a great extent, be sifted out of the central portions of the sand-waves, which will finally attain a density sufficient to oppose even the full strength of the current. This, therefore, will become more and more diverted from its rectilinear direction, and the curved channel-way becomes permanent, but will always be less marked at high than at low water.

In this description I have assumed that the banks are too solid to be affected by the current, although in general practice this is not the case; but I wished to show that, even under the very favorable and unusual conditions assumed, the curved channel-way is inevitable in streams which flow over beds of movable materials.

In nature the banks are generally very unstable and easily eroded by the current; they present, as a general rule, less resistance to the water than does its bed, and hence the curved shape, set up by the causes cited above, will soon be greatly increased and rendered permanent.

All the phenomena of bar-formation can be traced to the interaction, here described, of the force of the moving water and the resistance offered by the materials over which it flows, although we will not often find cases as simple as the one here presented. In actual practice there are generally many complicating causes to discover and eliminate, but the general action is always the same.

In considering now the case of actual streams, we must remember that their present beds, as well as their banks, furnish inexhaustible supplies of sand, gravel, and mud. The complications of water-flow due to their action cannot, therefore, ever be entirely eliminated, although it is a very serious question whether means will not have eventually to be taken to prevent the washing of the banks on the tributary streams at least, as many of these bring in quantities of sediment utterly disproportionate to the amount of water which they contribute.

I will now endeavor to describe the variations from the simple manner of bar-formation which are met with in practice: these vary greatly for different rivers, as might be supposed, but for the same stream they are measurably constant; the variations, such as they are, being due to the character of the materials moved and to the force and volume of discharge of the water. The streams which I select as typical are the Upper Mississippi, the Missouri, the Ohio, and the Lower Mississippi.

The Upper Mississippi flows over very heavy sand, and its banks are composed of similar material. The general course of the river is quite straight, and the total fall is considerable. The volume of water discharged is also large, but the floods, although heavy, are not of very long duration. The banks are very easily abraded, while the material composing the bed is hard to move, and the stream has therefore attained an extraordinary width between banks, while great complications in the formation of the sand-waves have resulted. The floods being violent, but of short duration, the crests of the waves are generally above the low-water surface, and they speedily increase in size by the drifting of sand under the action of the wind; then follows a growth of willows or cottonwoods, and we have an island. Either an island or a dry bar will act like one of the natural banks, and an independent wave-formation will be set up in every separate channel thus formed.

The Upper Mississippi has an immense number of islands, large and small; hence, there are a great many channels and considerable complexity of bar-formation. The great extent to which the water is scattered prevents vigorous or sustained action on the sand; the bed of the river is covered with different sets or systems of sand-waves, due to the numerous channels, and navigation is much impeded. Nevertheless, no stream with which I am acquainted shows so well the method of simple formation of bars which I have attempted to describe; the complicated channel is a natural consequence of the small supply of water and undue proportion of sand.

The Ohio resembles the Upper Mississippi in many respects, but its floods are far more violent, and its low-water stages more general and lasting. The bed is generally composed of heavier materials, and much gravel is moved, while the banks are but little eroded.

Islands are not very numerous, and the bars are usually simple in their formation, but contain much gravel. The low-water discharg the river is so small as to be usually inadequate to the task of breaking through them; hence, low-water navigation is very bad.

Both on this stream and the Upper Mississippi the channel is not liable to sudden and radical changes as on the Missouri.

The Missouri, although not the greatest in volume, is nevertheless the tributary which most resembles the main-trunk stream. It is very peculiar in its action, although all the observed phenomena are easily explained. Its volume and slope do not differ materially from those of the Upper Mississippi, yet the velocity of the current is probably twice or three times as great. This fact can only be explained by the supposition already mentioned, that it is due to the great mobility of the bed, and consequent small amount of friction, which enables the velocity to approximate, more nearly than is usually the case, to that due to the actual descent of the stream. The velocity varies from three miles to at least nine miles an hour.

The bed and banks are composed principally of an almost impalpable sand; heavy sand is rare, and gravel is usually only met with near the bluffs. As might naturally be expected, the amount of disturbance of the bottom is enormous, the water penetrating it to considerable depths, and whirling along great masses of sand, which is so fine that a very large amount is suspended and carried forward by the water, in addition to that which rolls along the bottom.

The rate of advance of the sand-waves is very rapid, but they are never allowed time to dam up the water to any extent. Their crests are always high and flat, and the water, even at high stages, is obliged to force channels through them. These cuts at once become reservoirs, into which pours the greatest body and the heaviest of the moving sand; consequently they soon fill up, and a breach is quickly formed at some other point. These sand-waves are generally greatly elongated downstream, but their shape is constantly changing, and they wash away and re-form with astonishing rapidity.

The increased discharge of floods gives the current an enormous increase of velocity, and, hence, of excavating power, and the amount of material moved keeps pace with the increased volume of water, and in consequence there is not much difference in the channel-depths at flood and at low stages.

The navigable channel is of course constantly shifting, being now on one side of the river, now on the other, and it requires the greatest skill and judgment on the part of the pilots who navigate it.

During very low stages the velocity is much reduced, and the pecu-

liar characteristics of the river are not so apparent, but slight causes suffice to disturb the equilibrium and effect great changes.

The banks are eroded with extraordinary facility, and as old logs and stumps are found buried throughout the valley, there seem to be good reasons for thinking that the river may have traveled over the entire width of its valley, perhaps more than once; at all events, land along its banks is held by a most uncertain tenure.

From what has been said it may readily be inferred that the effect of any engineering constructions, as is also true of natural obstructions, will be very marked and speedy, but not necessarily permanent nor easy to maintain.

After joining the Upper Mississippi, the turbulent propensities of the Missouri are a good deal curbed by association with its more orderly partner, and the heavy sand of its new bed also tends to bring about this desirable result; but nevertheless, its influence is still quite apparent, and manifests itself especially in the instability of the channels during low stages.

After passing Cairo we reach the Lower Mississippi proper.

We have now left the rock-bluffs behind; hence to the Gulf the banks, with a few exceptions, are uniformly composed of layers of sand and clay, surmounted by a stratum, about 30 feet thick, of alluvial soil. These banks, except where under cultivation, are covered with a rank, heavy growth of timber, and the bars which emerge from the river are speedily taken possession of by a dense growth of willows and cottonwoods. The curved formation being entirely unopposed, is very strongly developed, increasing, however, as we descend the river and as the velocity of the current diminishes.

The bluffs which touch the river at Memphis, Vicksburg, and a few other points, the most southerly of which is Baton Rouge, are composed principally of sand, with some clay and gravel; the sand being often partially cemented with iron-ore.

There is quite a large number of islands, generally of considerable size and tolerably stable. The manner of their formation will be explained further on.

The bed proper of the stream is a peculiar tenacious clay, as already stated, but on this bed rest the immense deposits of all kinds of material brought in by the tributaries or precipitated into the stream when the banks are undermined, and it is the action of the water on these deposits, moving them and heaping them up in certain localities, which gives rise to the bars.

Although the principle governing the formation of these obstructions is precisely the same as in the similar cases, yet the peculiar circumstances under which it occurs causes a good deal of variation from the simple type.

The principal cause of variation lies in the curved shape of the stream, which is very marked and persistent; consequently, at all stages of water, the channel is more or less curved, and this shape determines the manner of deposition of the materials moved by the water.

In discussing the case of a straight channel-way, it was stated that the heavier materials would follow the thread of the strongest current. This is still true in the case before us, but, owing to the great curvature of the bed, the question of the location of this current is no longer as obvious as before. As a matter of fact, it varies with the stage of water, and will always be found following a path as nearly direct as possible, which throws it more or less directly from one point to another, and as the river rises it approaches more and more closely to these points.

The great volume and force of the river enables it to move both gravel and heavy sand, and these will be deposited near the points, or wherever the high-water channel may be. As the river falls the diminished velocity renders it incapable of moving these deposits, and the water is gradually deflected by them toward the bends.

These constant accretions of heavy material will, of course, gradually extend the points, thereby encroaching on the space occupied by the water at lower stages, and as the banks offer less resistance than the bed they will be eroded and the bend will be elongated; it is thus that the curved form is perpetuated and constantly increased.

In emerging from a bend the water spreads out in a fan-shaped mass, the strongest current taking the shortest available route. It might be inferred from this that a section across the stream would show the greatest depth where the current is strongest, but the reverse is usually the case; the extra velocity simply moves more or heavier materials, and the depth is not increased. From one side of the fan to the other we have all grades of velocity, and similarly all grades of material. Finally, between the extreme edge of the sand-wave and the concave bank we have a very deep pool, in which the velocity is relatively quite small. These pools receive only the lightest deposits—principally mud; they are partially filled up at high water, but are scoured out at low stages, even down to the main clay-bed.

The sand-waves still retain their characteristic features, but the heaviest portions, instead of being at the center, now lie alternately on opposite sides of the stream and near the points.

The erosion of the banks and the extension of the points gradually elongate the bends, and after a time the additional resistance thus offered to the free discharge at high water, and which is always represented by a ponding back and consequent increase of head, causes the current to cut a channel through the point-bar; this becomes a permanent outlet for flood-discharges, and the bar outside becomes an island. Outside of this, other bars form, and in their turn become tow-heads and islands.

There is no doubt whatever that all the Mississippi islands have been formed in this way, or else by cut-offs.

The channels behind them are called chutes, and are essentially high-water channels, and the absurdity of endeavoring systematically to turn the low-water channel into them should, it seems, be obvious; nevertheless it is constantly being proposed, not only by amateur engineers, but also by men who should know better. The chutes are merely vents for the discharge of floods, and as they furnish the most direct route, a great portion of the heavy material in motion, comprising not only gravel and heavy sand, but logs, snags, &c., naturally passes through them. The snags and logs often lodge, as the chutes are not usually deep, and in any case it is safe to count on finding the bottom composed mainly of gravel and very coarse sand. These chutes are, as a general rule, dry at low water, and are only used by boats ascending the stream during high stages.

It frequently happens, however, that great erosion takes place in them, increasing their length to such extent that the maximum velocity of the current is no longer found in them; in this case the chute no longer goes dry at low water. Finally, by some means the high-water discharge may be diverted into the bend, which at once fills up, and the chute becomes temporarily, or even permanently, the main channel of the river. This shifting of the channel from one side to the other of a bar or island is not an uncommon occurrence at low water, provided

the length, and consequent fall, in the two channels does not materially differ.

As the various actions here described are constantly going on, the bars on the points constantly advancing, and the shores of the bends receding by continual erosion, it may well be asked where this action is to stop, and what there is to prevent an indefinite lateral extension of the river-bed.

If caving of the banks were only confined to the apices of the bends, this action would go on until the channel had been so much lengthened that the current velocity would no longer be equal to the task of transporting the sand, and consequently the latter would accumulate until the whole bed of the stream would be raised, and new conditions of flow be set up. But, as already stated, this condition of affairs rarely occurs, for the caving of the banks almost always extends to a considerable distance to each side of the apex of the bend, and the neck of land between two consecutive bends, being eroded on both sides, gives way, and a cut-off is formed.

In this manner, or the one previously described, the length of the river is preserved from any great variation.

I have as yet said nothing about the absolute size and extent of the sand-waves, and this I purposely left unsaid, for the greatest possible variety is to be found among them. It will not, however, be difficult to infer, from the foregoing remarks, that their absolute dimensions, as well as their position, will vary from year to year. Their dimensions must always express the difference between the carrying and depositing action of the stream, and this of course varies greatly according to the relative amount of water and sand supplied each year. As already shown, the different tributaries furnish sensibly different materials, which difference influences this question greatly, and the length and extent of the floods is also a very important consideration. A short, violent flood creates a great disturbance on the bottom, and sets many large sand-waves in motion, but as the velocity of the current is quickly checked by the rapid fall of the water-surface, it is quite unable to cut its way promptly through the extensive shoals created. Shoal water for the whole season invariably follows a sudden rapid fall. If the fall is gradual, the motion of the sand-waves ceases before the velocity of the current is too much reduced, and further supply of sand being thus cut off, the greater portion of the wave is carried off by the current, leaving only such a barrier as can be broken through during low water with comparative ease.

There are generally two floods in each year: the first occurs usually in March or thereabouts, and is called the spring rise; the second is called, from the month in which it usually occurs, the June rise.

The spring rise, being generally due to the melting of snow, &c., on the lower portions of the streams, may be considered as mainly local, and as the greater portion of this influx of water runs off or out of the banks, a great deal of soil accompanies it; hence, the spring rise is generally a very muddy one, and the quantity of material moving is a maximum.

The June rise generally comes from the headwaters, and, owing to the distance that it travels, it brings comparatively little sediment with it; and although it sets the sand-waves again in motion, it rather decreases than adds to their magnitude, and is therefore of decided advantage to navigation. In fact, when the June rise is small, or, as sometimes happens, altogether wanting, a shoal-water season inevitably results.

So far we have looked upon the bars simply as evils to be deprecated; but there is another side to the question. All the streams are liable to great floods, which carry off in a very short time a large percentage of the annual discharge. During the remainder of the season there are but small additions to the volume of water, and were it not for the peculiar formation of these streams they would go dry, like ordinary torrents; but the shoals hold the water back, and it is stored up in the deep pools, to be drawn out gradually as the season advances.

On the large streams, these pools always contain enough water to maintain fair navigation through the dry season, provided it be used with discretion; but any attempt to tap them too soon, or too lavishly, will, by prematurely draining them, increase rather than remedy the evils complained of.

When an improvement is projected, the bars must be looked upon as dams and treated accordingly, it being borne in mind that it is better not to increase the actual flow over the dam, but rather to decrease its width and increase its depth, the flow of water remaining the same. When properly done, this need not disturb the normal state of affairs, while it will afford to navigation all the facilities required. Should, however, ill judged measures result in drawing down the level too rapidly, it will be found that other bars, which had before been too deeply submerged to attract attention, will now be sufficiently near the surface to become obstructions in their turn, and to require works for their removal.

The persistency of the principal bars is remarkable; indeed, it is probable that many of them are only disturbed by the exceptionally great floods which occur at long intervals, and generally cause great changes throughout the whole length of the river. This persistency can only be accounted for by the sifting process before alluded to. Every minor flood sweeps out the lighter portions, leaving the heavier ones behind, and as this occurs year after year, it follows that the solidity of the bars must constantly increase, with the results stated above.

The fact that these bars remain in one place does not conflict with the general motion of the sand-waves, as the latter are formed of the loose materials lying along the points, or in the pools, and which receive constant additions every year from the caving of banks and the influx of the tributary streams. The permanent bars are deeply buried under this flood of sand, whose waves move on their course above them; it is only when the river has fallen considerably that their location begins to be apparent. The first motion of the sand-waves, caused by a rise, fills up all inequalities in the bed of the river behind the main bars, and even the beds of the pools are greatly raised.

It is always found that, during every low-water season, a limited number of bars show considerably less depth of water than the others, and hence form the gauge to which navigation must adapt itself.

As far as my experience goes, this is always due to local causes, as examination reveals the presence of an undue amount of gravel or other heavy deposit occupying not only the site of the high-water channel, but that of the low-water channel also. This rule I believe to be invariable, and I regard the proper apprehension of it to be of the greatest importance.

Where bluffs are near the river much gravel is brought in by small creeks, and such localities are almost always troublesome, especially if they be near the mouth of some tributary which is liable to bring in considerable sediment.

On the Lower Mississippi this cause is not of frequent occurrence,

but it is, nevertheless, gravel in the low-water channel which causes the trouble. I account for this unlooked-for deposit as follows: in the constant changes which have been going on in the river, it has frequently happened that a combination of circumstances has directed the ordinary and low-water channels of the river over ground which had formerly been occupied only at high water, and in such cases great beds of gravel, due to old floods, are uncovered, either on the banks or in the bed of the stream, and being washed into the low-water channel, retard the process of cutting out, besides producing other complications.

Another agency must, however, be noted here: As already stated, the sand-waves move on, irrespective of the permanent bars below them, and it may, and quite often does, happen that a large wave may stop on one of these bars when the river falls; when this occurs the crest of the bar is of course much raised above its usual height, and it will become a prominent obstruction for the time being. As a general rule the next flood removes it, although in some special instances several seasons have been required for the purpose. When an engorgement of this kind takes place at a bar which would be troublesome under any circumstances, the effect is very marked, the ponding back of the water extending over very great distances. Thus, in the low-water season of 1871, the bar at Turkey Island, about sixty miles below Saint Louis was gorged in this manner, giving only 4 feet available depth, with a very changeable channel. The water was so backed up that the gauge at Saint Louis read 5 feet above low water, although at all other points along the river below the bar it seemed to be at its lowest stage. The bad bars between Saint Louis and Turkey Island never had less than 7 feet of water over them while this gorge lasted, whereas their depth the next year was less than 4 feet. During the same season Reeve's Bar, just below Memphis, was gorged in a similar manner, with a channel-depth never exceeding 4½ feet, and in consequence the bars between Memphis and Cairo gave not less than 6 feet of water instead of 4½ feet, which is to be expected under ordinary circumstances.

In all cases of bars which are habitually bad we find an unusual width of river. This is due to the action of the gravel-deposits before mentioned, by which the low-water current is directed against the banks, rapidly eroding them, and the channel being already choked with sand keeps constantly shifting, while the current attacks both shores indiscriminately. In this way a great width is soon attained, and the regular bar-formation is entirely broken up. The gravel and other heavy materials brought down by the flood-current are deposited without order or regularity, and as the great width of the river reduces the current-velocity, deposits of gravel, &c., arriving from above, are stopped in these wide reaches, as the current is not strong enough to keep them in motion. By the shifting action before mentioned the lighter materials are swept away, while the heavy ones remain, and they are frequently distributed across the whole width of the bed; the low-water discharge is obliged to force its way through these heavy deposits, the result being a very shallow channel, uncertain in location and constantly shifting.

In cases like this, the obvious method of improvement needed is to restore as much as possible the curved channel-way, which alone secures permanence or regularity of action, as by this means the high-water channel will be separated from that of low water, and will be at liberty to deposit its gravel, &c., where it will do no harm. The width of the stream must at the same time be reduced to its usual amount, and the reach may also require to be shortened, so as to increase the slope and velocity to the proper extent. It is quite probable, too, that in a case

of this kind, dredging on the line of the proposed low-water channel would be highly beneficial, as it would hasten the cutting-out of this channel, and lessen the danger of the current seeking some easier but less desirable outlet than the one selected.

It is frequently asserted, and no doubt with truth, that navigation on these streams is constantly and steadily deteriorating; this, it is stated, is due to the fact that the floods are more violent, and of shorter duration than formerly, the reason being that owing to the great increase in the extent of land under cultivation, the rain-water falling on it is at once absorbed, and speedily finding its way into the river runs off and is lost. Before the ground was cultivated the tough prairie-sod was almost impervious to water; hence the rain-fall was stored up on the surface, and was only drained off by degrees. The floods were, therefore less violent and of longer duration than at present.

But this is not the whole trouble. Violent freshets, as has already been explained, bring down greater masses of sediment and cause greater erosion; the wash of steamboat-wheels, and the many influences which men exert upon these rivers, also cause a great increase in the rate of bank-erosion, both on the tributaries and on the main stream. From all these causes it follows that the amount of sediment yearly poured into the Mississippi is steadily becoming greater, and the depth on the bars is decreasing. Many persons have inferred that there is even danger of the stream raising its bed, but this apprehension seems to be without foundation; for as long as the banks offer so little resistance the stream has no difficulty in obtaining all the channel-way needed, and hence no rise in the level of water-surface is likely to occur; it has to destroy the banks, leaving the heavy deposits of the bed untouched. From this action results a great increase of width, and the depth must be reduced in like proportion, owing to the decrease in scouring force; moreover, the bed being wider, the channel is not forced to one definite location, but has unchecked opportunity for annoying changes.

Within the memory of living pilots the shoal water has extended down from Plum Point, one hundred miles above Memphis, to Lake Providence, fifty miles above Vicksburg, a total distance of four hundred and fifty miles; and as these disturbing causes will act with more vigor every year, it is time that we should fairly face and realize the fact that, unless speedily checked, there are natural causes at work which will eventually destroy the navigability of the Mississippi and its tributary streams.

From what has been said it may be readily inferred that a wholesale revetment of the Mississippi banks would entail the gravest consequences; the bed would infallibly be raised by the accumulation of deposits, and disastrous inundations would result.

The influx of sand from above must first be stopped, then the river will have a chance to clear itself, and, as its width contracts, the shores can be revetted to prevent any further injurious changes.

Before entering on the subject of improvement, however, it will be well to describe briefly the manner in which boats usually run, either from convenience or necessity, as this must necessarily have an important bearing on the subject.

During extreme flood-stages the bars are deeply submerged, and the current, as before stated, approximates in direction very nearly to the shape of the river. Down-stream boats run pretty nearly in mid-stream, occasionally nearing the bend-shore when the curvature is considerable. Up-stream boats, however, keep as near the points as possible at this stage, and also use the chutes, for although they meet a stronger current

the distance saved is so great as to compensate for the disadvantage of additional resistance. As the water falls the chutes soon get too shoal for safe navigation, and the water begins to draw away from the points and into the bends; down-stream boats then have to run the concave shores or bends, but up-stream boats keep up over the bars as long as it is safe to do so. Finally, the water begins to pond up behind the bars, and the depth on the crest decreases until a breach is formed, or, as the pilots say, "the bar cut out," and through this gap both up and down-stream boats must pass, and as the water continues to fall this cut fills up, and after a time another one forms, but higher up stream, and generally of less depth. This process is usually repeated several times, till finally the channel may lead square across the stream, and be neither wide enough nor deep enough for the wants of navigation. Such is the usual programme, which, however, may be considerably varied.

The cutting-out process explains the anomalous fact that the river may fall considerably with decided advantage to navigation, while a rise may produce diametrically opposite results by filling up the cuts through the bars, without giving depth enough to go over them. Occasionally, however, the river falls so low as to be utterly unable to maintain a channel, and in this case a small rise generally does much good by increasing the volume of discharge and cutting out a good channel through the bars; but to effect this it must not of course be high enough to flow over them.

A long stand at one stage is also advantageous, as it gives time for the water to concentrate and gradually to cut out a channel.

Such being the principal facts observed, it remains only to consider the principles upon which an improvement should be based.

It must first be laid down as a cardinal principle that no work should be allowed which will interfere with the present navigation. As boats, during high stages of water, depend upon the use of the various chutes and other similar channels, as an important means of saving distance, it would manifestly be improper to project any works which would prevent this use, except in cases of absolute necessity, and it is thought that such cases will be very rare.

As I have endeavored to show, the small depth on the bars is due to the reduction in velocity and scouring power which follows a diminution of the discharge; hence it follows that the remedy should consist in increasing the velocity to the extent necessary to accomplish the work desired.

No matter how low the Mississippi may be, there is always a sufficient amount of water passing to form and maintain a channel of the width and depth deemed necessary for the wants of navigation, but this water is scattered over so wide a channel that its capacity for work is nowhere utilized. It therefore follows that, by a proper amount of contraction applied to this wide, shallow channel-way, the volume of water can be so far concentrated as to furnish the scouring power needed.

It must be remembered that all channels through the bars, whether natural or artificial, will be filled up when the sand-waves begin to move. The tardiness with which they again form naturally is the great impediment to navigation, and the object of any works of improvement must be to hasten and direct this process, so that the channel will always be found in the same location, will be formed promptly, and will furnish the depth deemed necessary for navigation.

From what has been said before regarding the distribution of the materials moved by the water, it must be evident that some portions of

the bars will offer far more resistance to erosion than others, and as these points are to be found in the high-water channel or channels, it would therefore seem a matter of common prudence to avoid these channels, in order to lessen the labor imposed upon the works of improvement. If these works are so planned as to direct the new channel to a point known to be in the line of high-water deposits, the work of preliminary excavation will be manifestly far more difficult than if lighter materials only were to be moved; and, moreover, each flood will fill up the new channel with these same heavy deposits, which must so often be removed.

It should, therefore, be laid down as a general rule, that, in the improvement of these rivers, the artificial channels should never coincide with those of high water, unless the special advantages to be gained are such as to balance the enormously increased expense and risk. It is not, of course, meant by this that the artificial channels should be made as indirect as is frequently the case when formed naturally; the increased scouring force due to the works of improvement will, as a general rule, render this unnecessary, and there is, of course, opportunity in this, as in most other things, for the exercise of good judgment.

Having settled the direction of the new channel, the next thing is to determine its dimensions, which should not be unnecessarily great, lest the pool above be drained off too rapidly. A safe rule to follow is to so proportion the opening that the total discharge over the bar may not be increased by the works of improvement, or, in other words, a sufficient portion of the water flowing *over* the bar must be cut off, and be made to flow *through* the bar and on the line selected.

The works necessary to accomplish this purpose will consist of dikes, built out from one or both shores.

Where several channels exist, one or more may be closed by dams, and this method, where practicable, has many advantages; it allows both ends of the dike to be secured; whereas in an ordinary spur-dike only the shore-end has this advantage, and in general the work of construction will be much easier.

In deciding which channel to close, it is only necessary to find and choose those through which the flood-waters pass. As I have previously stated, these channels are generally only navigable at high water; they are filled with the heavy deposits of that stage, and should, therefore, always be closed in preference to the others. In some instances there will be but little choice in this respect, and when this is the case, the channel offering the best general advantages may be left open.

The height given the dikes will depend upon the work expected of them. They should obviously be kept as low as possible, both from motives of economy, and in order to impede the flood-discharge as little as possible. This matter also affects navigation very materially, especially where any of the minor channels are closed; as these are navigated up stream at high water, or in fact whenever there is enough water to admit a boat, it follows that any works erected in them should interfere as little as possible with up-stream navigation.

A certain height is, however, necessary, in order that the dike or dam may begin to deflect the water in the desired direction before its volume and scouring capacity are too much diminished; and I think that a height of 10 feet above extreme low water will probably be sufficient for this purpose, while the injury to navigation will be small.

The precise manner of constructing these dikes must be largely a matter of experiment. They will usually have to be built on sand or, at best, gravel, and must therefore have a broad bed of brush, to prevent

them from sinking; above this, the dike should be composed of layers of brush, weighted down with broken stone. The root of the dike, that is, its junction with the bank, must be well secured, to prevent the water from getting around it.

In some cases it is thought that training-dikes may be needed to deflect the high-water discharge from that portion of the river-bed through which it is desirable to cut the low-water channel; these works will be more costly and difficult of maintenance than those already mentioned, but the method of construction will be the same. They should only be resorted to where it is absolutely necessary.

In order to hasten or assure the formation of the new channels on the selected lines, dredging will, in some cases, be of service, and this will especially be the case where it is necessary to take the channel through a bed of heavy deposits. These may be dredged out to advantage, for, if the contracting or training dikes are properly located, they will not be likely to deposit again; but it must be distinctly understood that the dredging recommended is only conditional upon the erection of the other works. Without them it would be of no service whatever.

In order to prevent injurious changes of channel which might destroy the effect of existing works or necessitate the construction of additional ones, a large extent of bank must be protected, and this item will be by far the most expensive and the most difficult portion of the improvement. The great height of the banks, the depth of the water, and the treacherous nature of the banks themselves, all combine to form a problem exceedingly difficult of solution. Either a succession of stone dikes or a continuous stone revetment may be used; both are very costly, the latter the most so, more especially as all the stone required will have to come from the Ohio or Upper Mississippi. Experiment may determine some cheaper material or combination of materials, and it is very desirable that such should be the case.

Finally, the security of navigation demands the removal of the snags and wrecks which incumber the bed of the river.

The removal of snags is a work of indefinite duration, and a fleet of boats must always be kept up for that purpose.

The removal of wrecks, although a good deal akin to the former, is nevertheless a work of far less extent, and may be completed in a few seasons. Special machinery is, however, required, and a boat should be properly fitted up for this special service, and be kept at work until the wrecks are all removed.

SPECIAL DESCRIPTION.

Having now given a description of the general characteristics of the river and of the causes operating to the prejudice of navigation, I shall describe as briefly as possible those places of difficult navigation which give less than 10 feet water at all stages. They are arranged in the order in which they are met with after leaving Cairo, and their approximate distance from that place is also given.

Wolf Island, thirty miles from Cairo, and just below Columbus, Ky.—This island divides the river into two channels, of which the left-hand one only is generally used. The right-hand channel is only available during high water. Just above here are bluffs, and the river is unusually narrow and deep. The washings from the bluff have obstructed the channel below to some extent, and have caused an undue erosion of the banks, thereby widening the river and shoaling it. *Least depth of water 8 feet.*

Phillips's Bar, fifty-seven miles from Cairo, and five miles below the foot of Island No. 8 (Sketches Nos. 1 and 2).—This shoal is probably caused by gravel from the Hickman Bluffs, which is washed down through the chute of Island No. 8. As is usual in such cases, the width of the river has been greatly increased by bank-erosion, which in this instance, however, seems to have been beneficial, by enabling the low-water channel to avoid the gravel deposits. In 1863 the channel led from Shotwell field to Phillips's house, directly through the gravel-bar, and the depth at low water was only 4 feet 2 inches. It is now, however, below this bar, and the depth has not for some years been less than 7 feet, and there will probably be no further trouble till the advance of the gravel shuts out the present channel also.

Island No. 10, *sixty-seven miles from Cairo.*—The river here is very wide, and the bed is much obstructed by wrecks. Owing to these causes the channel is shifting, and *gets down to* 8 *feet.* The banks throughout the bend above are caving very badly, thus adding to the trouble below.

New Madrid, eighty miles from Cairo.—In the bend below town, just above Dr. Martin's (Sketch No. 3), the river is much obstructed by rack-heaps, and the hulls of steamboats that have been wrecked on them. The depth of *water at low stages is 7 feet.*

Point Pleasant, eighty-seven miles from Cairo (Sketches Nos. 3 and 4).—This is one of the habitually bad places. The river, as will be seen, is nearly double its usual width, and the bed is covered with gravel deposits. This gravel is probably due to old changes in the river, as it is known that several islands have been lost sight of in this neighborhood, and it is quite possible that the present channel leads through some of the old high-water deposits. As might be expected from its general characteristics, the channel at low water is shifting and uncertain. It generally gets down to 6 feet, and has been as low as 4½ feet.

Tiptonville, ninety-one miles from Cairo (Sketch No. 4).—The river here is also very wide, and the channel is somewhat shifting. It gets down to 8 feet.

Head of Island No. 16, *one hundred and sixteen miles from Cairo* (Sketch No. 5).—The river here spreads out to a width of one and one-half miles, and is proportionately shoal. There are two low-water channels, as indicated, which have about the same depth of water. There are very extensive rack-heaps in the river opposite Bell's Point, which, by deflecting part of the water toward the Tennessee shore, may have caused the trouble here. The low-water channel depth is 6 feet.

Island No. 18, *one hundred and twenty-six miles from Cairo.*—There are three channels here, although only the extreme left-hand one is now generally used. The best water is sometimes in one, sometimes in another, and the least depth is 8 feet.

Island No. 21, *one hundred and thirty-six miles from Cairo.*—There are two channels here. The right-hand one alone is used. It is a good deal obstructed by wrecks, which have caused the formation of a large bar along the Missouri shore, above Mrs. Hickman's. The channel goes outside of this bar and gets down to 7½ feet.

Head of Island No. 26, *one hundred and fifty-two miles from Cairo.*—River wide and channel somewhat shifting; sometimes becomes troublesome, but the usual depth of late has not been less than 9 feet.

Plum Point.—Sketches Nos. 6, 7, and 8 show the river around Plum Point, which has always been regarded as the worst place on the river. The length of this reach, which extends from foot of Island No. 26 to the head of the bluffs at Fort Pillow, is twenty miles. The width of the

river varies from one to three miles, and there are several islands and many immense sand-bars which are dry at low water. This reach exemplifies in the fullest manner the troubles attendant on excessive width, which have been described in a previous portion of this report. The low-water channel may be found anywhere between the two banks; it is constantly shifting and is often much divided. The bed of the river has become a receptacle for the gravel carried by the current at high water, and the incessant erosion of the banks tends to keep up this bad state of affairs. The improvement of this place will require careful study.

Foot of Island No. 26, one hundred and fifty-seven miles from Cairo (Sketch No. 6).—This is the first crossing in Plum Point Reach, and is liable to change slightly. It gets down to 5½ feet.

The next crossing, *Fletcher's* (Sketch No. 7), is changeable, and sometimes shoal. At present, it leads very squarely across the river, but gives 10½ feet.

Elmot Crossing (Sketch No. 7), the next below Fletcher's, is also changeable, but at present gives 12 feet.

Foot of Island No. 30, one hundred and sixty-six miles below Cairo (Sketch No. 7).—This is the next crossing below Elmot's. It is very changeable and generally very shoal, often giving less than 5 feet.

Osceola, one hundred and seventy miles from Cairo (Sketch No. 7).—This is next below the previous crossing, and has the same characteristics and depth. The last crossing in this reach, that at the foot of Bullerton tow-head (Sketch No. 8), is also frequently very changeable. Just now it is comparatively good.

Island No. 34, one hundred and eighty four miles from Cairo.—There are two channels here, but the one down the chute is the best, and is now always used. It gets down to 8 feet.

Devil's Elbow, two hundred and fifteen miles from Cairo (Sketch No. 9).—The channel has, for many years, been down the chute of Island No. 37. This has, however, caused gravel-bars in the old channel to produce an undue erosion of the banks below the island.

The crossing from the foot of the chute to Sexton's gets down to 6 feet; the lower crossing from Point Able to Charley Morris's gets down to 8 feet.

This portion of the river is extraordinarily crooked, and the bends have become so long that they all have a tendency to fill up, the chutes thus becoming the main channels. As an example, Sketch No. 10 shows Brandywine Bend, the next below Devil's Elbow.

Fogleman's Chute, generally known as the Outlets, will, it is thought, become the main channel before many years.

Island No. 40, two hundred and thirty-four miles from Cairo (Sketch No. 11).—The bend here is also very long, but there will probably be no change of channel until one occurs above. The chute is now dry at the head in low water. Above Redman's Point the river is very wide, and there are two low-water channels. Depth of water, 6 feet.

Just below Memphis lies President's Island, at the foot of which there are some very troublesome shoals. These are illustrated by sketches Nos. 12, 13, and 14. They are, I think, due, without any doubt, to the great masses of gravel which have been washed out of the bluffs at Memphis. The natural route for this gravel has been down the chute of President's Island, but enough has been deposited on the bar at its head to keep up a rapid extension of the bend, which is still going on. The gravel which passes down the chute is deposited in large masses on the bed of the river, from the foot of President's Island to the head of Cow Island, No. 47, and it is almost impossible for the low-water current to

excavate a channel through it. There is a good deal of water goes down the chute at low stages, which might be cut off and sent down the bend, to assist in maintaining a channel through the gravel, but this will necessitate reveting the shores of the bend, which are already caving badly. Deflecting dikes below may also be necessary; but the main point, I think, will be, first, to dredge a deep, wide channel through the gravel, and then, if need be, to construct additional works to assist in keeping this channel open. The first of these shoals is at the—

Foot of President's Island, two hundred and fifty-seven miles from Cairo, and eight miles from Memphis (Sketch No. 13).—This crossing gets down to 6 feet. The next one is at—

Reeve's Bar, two hundred and fifty-nine miles from Cairo (Sketches Nos. 13 and 14).—This is the worst of all, as it gets down to 4½ feet, and the channel is constantly changing.

Horn Lake, two hundred and sixty-one miles from Cairo.—This is the lowest of these crossings; it is also changeable, and at times quite shoal; of late the least depth has been 7½ feet.

Harklerodes, two hundred and seventy-six miles from Cairo.—Gets down to 9 feet.

Commerce, two hundred and eighty-seven miles from Cairo.—Gets down to 8 feet.

Below here the cut-off of last summer has completely unsettled the channel as far down as Bordeaux Chute.

Sketch No. 15 is appended to illustrate what has been previously said regarding the method of formation of islands. This sketch shows the cut-off formed below Commerce last summer, which cut off Council Bend and made an island of Linwood Point. At the lower end, it shows an instance of the successive formation of islands outside of a point which accompanies the extension of a bend. This formation is a very old one, being shown on the maps of 1821 substantially as it is to-day, but, within a few years, the elongation for the given slope having become excessive, Walnut Bend filled up, and the main channel is now down Bordeaux Chute. It seems quite probable that if the cut-off at Commerce had occurred earlier, this change might have been at least deferred, and it still remains to be seen how the channel here will ultimately be affected by the change above. If the filling up of Walnut Bend had not been so far advanced, there would, I think, be little doubt that it would have been reopened by this change, but, as it is, the lost length will perhaps be more easily regained by erosion elsewhere.

Ship Island, three hundred and eleven miles below Cairo (Sketch No. 16).—The river here, as shown, is very wide; the channel is shifting, and gets down to 5 feet.

Shoo-fly Bar, three hundred and fifteen miles below Cairo (Sketches Nos. 16 and 17).—This is a very bad place. The river is exceedingly wide, and, as usual, a gravelly bed and shifting channel are the results. There are deposits of gravel along the shores, and as a good many changes are known to have taken place in this neighborhood, it is quite possible that the trouble here may have originated with some of the deposits in the old high-water channels. Be that as it may, the present condition of affairs is such that further deterioration may be looked for, all the causes being at work which have already been adverted to in general terms, and also described as in action at Plum Point. The low-water depth is 5 feet.

Helena, three hundred and twenty-nine miles from Cairo (Sketches Nos. 17, 18, and 19).—We have here a wide and comparatively straight reach of river, extending from the mouth of the Saint Francis to the foot of

Montezuma Tow-head. The great width, probably due to the influx of the deposits of Saint Francis River, renders the channel exceedingly uncertain and changeable. At various times, too, some of the crossings have been very shoal, although this has not occurred recently. The lowest depth reported was in 1863, 4½ feet.

Montezuma Bar, three hundred and thirty four miles from Cairo (Sketch No. 19).—This is also a very wide place; the channel shifts a good deal, and gets down to 7 feet.

Island No. 63, *three hundred and fifty-six miles from Cairo.*—The river here is divided up into several channels, and the low-water depth is 8½ feet.

Head of Island No. 66, *three hundred and seventy-five miles from Cairo* (Sketch No. 20).—The river here attains an undue width in the bend abreast the shoulder of the island, and the water, being split up into several channels, generally fails to cut a passage of proper depth into the bend. The depth at low water is only 6 feet, and the channel is liable to change. The trouble was probably originally due to accumulations of rack-heaps, which arrested the moving gravel, and caused the formation of bars which the current is now unable to remove or cut through.

Head of Island No. 69, *three hundred and ninety-five miles fom Cairo.*—The channel at the head of the island gets down to 7 feet.

Choctaw Bend, four hundred and sixty miles below Cairo (Sketch No. 21).—This is a very bad place; the low-water channel is shifting and uncertain, and its depth is only 5 feet. Rack-heaps at the head of the bend, and heavy gravel-deposits on the head of Island No. 78, have caused a great widening of the river at the expense of the Mississippi shore. From this has resulted a great decrease in scouring power, and the bed of the river is largely covered with gravel. The situation is so similar to that at Island No. 66 (Sketch No. 20), that it seems quite reasonable to infer that, similar causes being at work, the latter place will eventually be as troublesome as Choctaw is now.

Greenville, five hundred and seven miles below Cairo.—This crossing is sometimes shoal, but at present gives 8 feet.

Vaucluse, five hundred and fifteen miles below Cairo.—Is liable to sudden changes, but generally gives 9 feet.

At Skipwith's Landing, five hundred and sixty miles from Cairo, begins a very troublesome piece of river, which extends to Short's Landing, below Lake Providence, a distance of about seventeen miles. In this distance there are usually five crossings, all of which are very shoal at low water, and are constantly changing. The river is very wide. Not more than 5 feet can generally be counted on at low water on any of these crossings. This is usually the lowest of the very bad places; below here, from 7 to 8 feet can generally be found.

The condition of the bars at Lake Providence has considerable influence upon the condition of affairs at Choctaw Bend, one hundred miles above. When Lake Providence is very bad, Choctaw is usually good, while the amelioration of the lower shoal (Lake Providence) soon causes the bad water at Choctaw. This shows conclusively the effect of these bars in ponding back the water above them, and at the same time serves as an illustration of the results which would follow too lavish a tapping of these natural reservoirs.

The first of the bad crossings is at the head of Island No. 93, five hunhred and sixty-four miles from Cairo (Sketch No. 22). Channel depth at low water, 5 feet.

The lowest crossing is opposite Lake Providence, five hundred and seventy-two miles from Cairo (Sketch No. 23). Channel-depth, 5 feet.

Island No. 95, five hundred and eighty-five miles from Cairo.—Tallula Bend is a good deal similar in general shape to that of No. 66 and Choctaw, but the channel-depth is not so much affected. It gets down to 8 feet.

Terrapin-Neck Cut-off, six hundred and ten miles from Cairo.—There are two channels here of nearly equal depth. The least depth is 9 feet.

The effect of very extensive bank-abrasion was well shown last summer, in the harbor of Vicksburg, Miss. After the subsidence of the great flood of 1874, the shore of the point opposite Vicksburg caved in to an enormous extent. The sand thus precipitated into the river was washed down into the bend below, and the crossing from Vicksburg to delta, which usually is over 20 feet deep, was shoaled to 8 feet. It is supposed that the next high water will remove this shoal, and it is only mentioned to show what very extensive and far-reaching effects may be produced by causes which at first sight may appear to be purely local. At the same time the bend of Diamond Island, sixteen miles below Vicksburg, filled up, and the channel established itself permanently in the chute. This change was also probably due to the excessive bank-erosion at Vicksburg.

Bonjurant's Point, six hundred and ninety miles from Cairo.—The crossing from above the Point to Bruinsburg gets down to 9 feet. The river is wide.

Hole-in the-Wall, seven hundred and thirty miles from Cairo.—The river here is very wide, and the channel-depth gets down to 9 feet.

Natchez Island, seven hundred and sixty miles from Cairo (Sketch No. 24).—The river at the head of the island is quite wide, and there are several channels. At low water there is usually about 7 feet channel-depth, although it is said that there has been as little as 4½ feet. If this information is correct, there is of course a possibility of a recurrence of this undesirable state of affairs. The bar is probably caused by gravel washed out of the Natchez bluffs, six miles above.

Saint Catharine's Bend, seven hundred and sixty-five miles from Cairo.—The river here is very wide, and split up, the bars being probably in a large measure due to the same cause as the one at Natchez Island. The low-water channel-depth is 8 feet.

Glascock's Island, seven hundred and seventy-nine miles from Cairo.—The river here is very wide, and recent changes in the channel have set the banks to caving at a rapid rate. Ellis Cliffs, six miles above, have probably contributed largely to the formation of the bars here. The low-water channel-depth is 7½ feet.

Jackson's Point, seven hundred and ninety-three miles from Cairo.—This crossing gets down to 9 feet.

Mouth Red River, eight hundred and twenty two miles from Cairo (Sketch No. 25).—A bad bar is frequently formed here by the deposits of Red River. The depth over this bar is often less than 10 feet, and is said to have been as little as 4½ feet, though it seems hardly probable that this is likely to occur frequently. It could only have been caused by a great flood in the Red River pouring out while the Mississippi was very low. Below Red River there is believed to be always at least 10 feet of water.

From this list it will be seen that between New Orleans and Cairo there are forty-three localities, scattered over eight hundred and twenty-two miles of river, where less than 10 feet channel-depth may be looked for at low water.

There are thirty-five places where less than 8 feet is to be expected,

twenty-two which give less than 7 feet, nineteen less than 6, and thirteen less than 5 feet. At all these places from five to twelve miles of river will need to be improved, and there is no doubt that works will be needed at many places not here enumerated, either to prevent injurious changes in the channel or else to protect the works of improvement themselves.

The cost of the work, if carried to the full extent recommended by the committee, will therefore be very great, and, until some work of this description has been tried, it would, I think, be quite unsafe to pronounce the undertaking feasible at any reasonable cost.

It must be borne in mind that no such work has ever yet been even attempted on the Lower Mississippi, so that we have really no experience upon which to base a decision; we only know that very great and exceptional difficulties are to be expected.

The cost of building and maintaining the dikes destined to contract the channel will not be nearly as formidable an item as that of the extensive bank revetments needed. These will be absolutely necessary to prevent the dikes from being cut loose from the shore, and also to stop the caving of the banks where injurious channel changes might result from a continuance of this action. As it is not an uncommon thing, even at low water, to find a depth along these caving banks of 50 or 60 feet and upward, and as the caving usually extends over lengths of many miles, the cost of protection, whether by continuous revetment or by spur dikes, will manifestly be enormous. It is, therefore, a matter of prime importance to keep this item of expense at as low a figure as possible, by care in locating the works of improvement, and by thorough experiments on different plans of bank revetment.

It must be remembered that the success of an improvement based on the employment of dikes depends primarily on their stability, as they act in the manner of dams, and are liable to be undermined, to be overturned by the water-pressure, or to be detached from the shore. The first danger is due to the treacherous bed on which the dike must be constructed, and can only be guarded against by the liberal use of brush as a foundation, in order to distribute the weight over as large an area as possible, and also to act as an apron in preventing scouring of the bed. In order to prevent overturning, a broad base is necessary, and the brush should be well ballasted with stone, and also further secured by piles. The danger of being flanked or detached from the shore is the most imminent, and arises from the instability of the banks. As before stated, the banks are eroded much more easily than the bed can be excavated, and any great resistance to the free flow of the water will be almost certain to increase the rate of bank abrasion at the site of the obstruction. This will render necessary the protection of the banks as stated, but I think that this expense may be materially reduced by proper precautions. It should be remembered that the duty usually imposed upon the current by an improvement of this nature is twofold: in the first place, it is expected to excavate a channel, and in the second place to maintain it; and of these two duties the first is infinitely the more difficult, while the second is the more important. The greater the amount of excavation required the greater must be the amount of contraction; in fact, usually far greater than would be necessary to keep the channel open when once formed. The protection of the banks must also be very thorough, or the dikes will be washed away and the whole work will be very costly, and even liable to defeat its own object by an undue amount of scouring, which would unduly lower the pool above, and also render the artificial channel liable to be blocked up by sand,

thus unnecessarily brought in. For these reasons I think that the scouring effect should be kept at a minimum, and hence the importance which I attach to separating the high and low water channels, in order that the latter may be filled only with light, easily moved materials, instead of gravel and the other heavy deposits of high water. For similar reasons I believe that the whole preliminary work of channel excavation should not be thrown upon the dikes, but should be largely performed by dredges. After this channel is once formed, if properly located, it will only fill up with comparatively light materials, which will be easily swept out by the concentration of flow due to the dikes. Even should this force not prove sufficient, I would still advocate a sparing use of dredges every season in preference to increasing the dimensions of the dikes beyond the extent deemed necessary to simply maintain the channel when once formed. I think that the rule already mentioned, viz, to maintain unchanged the amount of the discharge over the bar, but to concentrate it into a comparatively narrow and deep channel, will prove a safe one.

I trust that I have given reasons enough to show that on this river the necessity of a full knowledge of all the facts in the case is absolutely necessary, before any estimate of cost can be made. Such knowledge can only be furnished by a thorough and exhaustive survey of the whole river likely to need improvement.

While I consider that the attainment of 10 feet navigable depth at all stages is *possible*, I am very certain that the cost would be quite prohibitory, if the full improvement were to be taken in hand at once. Moreover, I think that the final cost would be very largely increased by such a procedure, owing to the great expense attendant on possible, and probable, mistakes in the location and construction. It is well, also, to remember that immense quantities of sand, the accumulation of years, must be moved out of the way before the work is completed, and that any very extensive and general disturbance of the bottom would certainly break up the normal regimen of the river, and probably produce complications of the gravest kind. I think, therefore, that the proper course to follow will be to make the improvement gradual and in a measure tentative.

To increase the low-water depth from 4½ feet to 6 feet, is, in my opinion, about as much as should for the present be attempted. This, in all ordinary seasons, will probably guarantee 8 feet, except for, probably, at the most, a few days in each year.

After this depth shall have been obtained, it will be easy to gradually increase the scope of the improvement, and ultimately it may be brought up to the full standard deemed desirable.

Experience gained in the preliminary work will form a certain guide for the more costly and extensive construction, and expensive and disastrous mistakes can probably be avoided.

A thorough survey from Cairo to the mouth of Red River cannot be made for less than $75,000. The work could all be done in one season, or spread over several, as might be deemed most desirable.

The work of improvement, could, however, be begun on the small scale recommended on the upper portion of the river, say between Cairo and Memphis, during the coming season, as soon as the survey of that portion of the river had been completed. At all events, everything could be got in readiness for work, and the necessary outfit of steamers barges, dredges, and other machinery could be procured; material for the dikes could also be got together, so that no time need be lost after the work had been definitely laid out.

I should therefore recommend for the coming season an appropri
of $200,000 to be applied to the improvement of the river between
and the foot of Reeves's Bar, just below Memphis, a distance of
250 miles.

For the surveys necessary in this same section $25,000 will be n
and for a survey of the remaining portion of the river $50,000 addi

The survey should be begun as soon as possible, and complete
ing the summer low water. The work of improvement could pro
be begun during the following winter.

Respectfully submitted.

CHAS. R. SUTER,
Major of Engin

Brig. Gen. A. A. HUMPHREYS,
Chief of Engineers, U. S. A.

C C 6.

FIRST SUBDIVISION OF THE NORTHERN TRANSPORTATION-ROU

REPORT OF MAJOR D. C. HOUSTON, CORPS OF ENGINEER

UNITED STATES ENGINEER OFFICE,
Chicago, Ill., January 6, 1

GENERAL: I have the honor to submit the following report
improvement of the Fox and Wisconsin Rivers, Wisconsin, cal
by the following letter:

OFFICE OF THE CHIEF OF ENGINEE
Washington, D. C., June 29

SIR: The river and harbor act, approved June 23, 1874, contains appropria
survey and estimates for the improvements recommended by the Senate Comm
Transportation-Routes to the Seaboard, upon four routes indicated in the repor
committee, to be expended in such manner as will secure the greatest amount
information for each of said routes.

The survey of that portion of the *northern route* designated "the Fox a
consin Rivers improvement, by which 5 feet navigation will be secured du
entire season, from the Mississippi River to Green Bay," is assigned to you.

The nature and object of this survey are fully set forth in the report of t
mittee with its appendix and evidence, copies of which have been forwarded
from this office for your information and guidance. You should, as far as
carry out the views of the committee.

The expenses of the survey will be borne by the appropriation for the impro
of the Fox and Wisconsin Rivers, it being understood that they are not to exc
amount of your estimate, viz, $10,000, and you will please enter upon this
early as practicable.

You will submit for the approval of this office a project for the prosecutio
work.

By command of Brig. Gen. Humphreys.

Very respectfully, your obedient servant,

JOHN G. PARKE,
Major of Eng

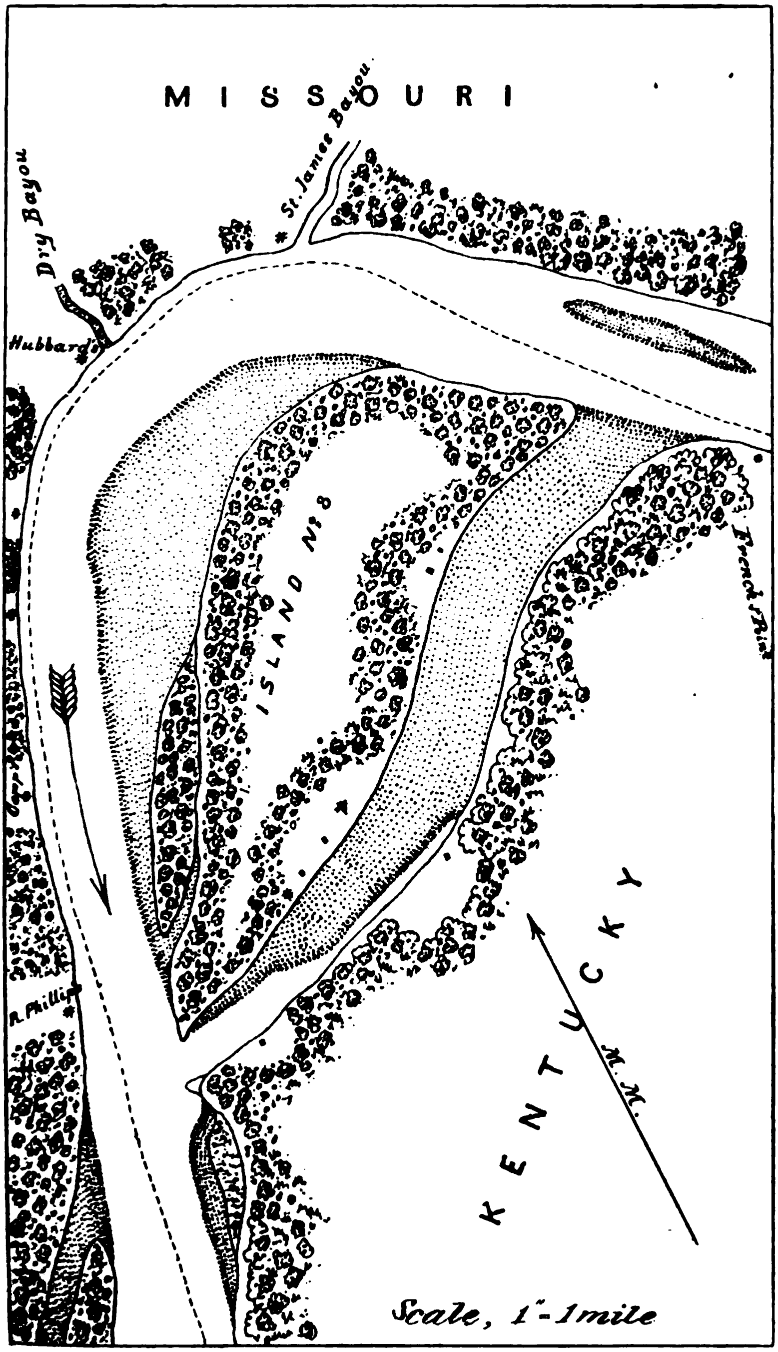
Maj. D. C. HOUSTON,
Corps of Engineers.

In compliance with the foregoing, I submitted the following p

UNITED STATES ENGINEER OFFIC
Chicago, Ill., July 9

GENERAL: I have the honor to submit the following project for the prosec
the survey of the Fox and Wisconsin Rivers, called for by your letter of June

MISSISSIPPI RIVER, SKETCH NO. 1.



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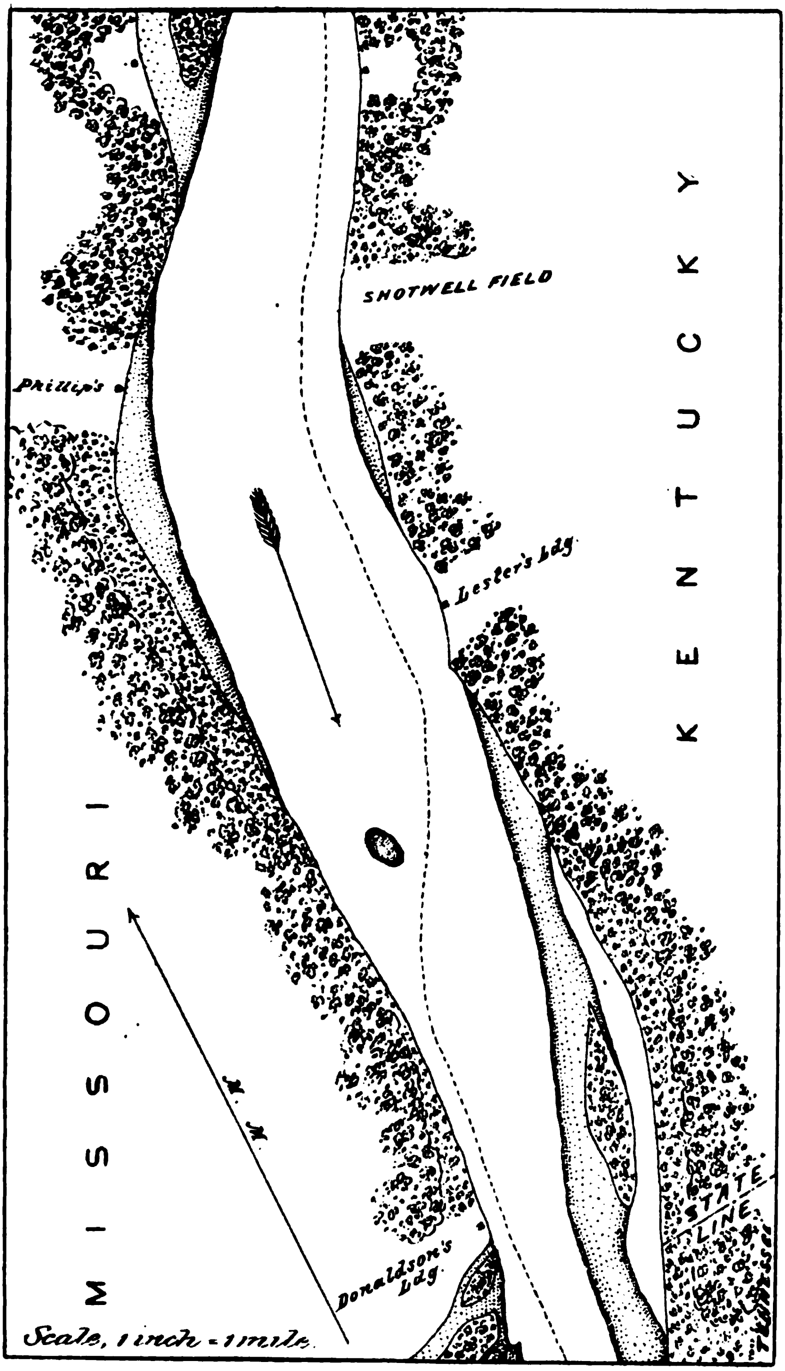

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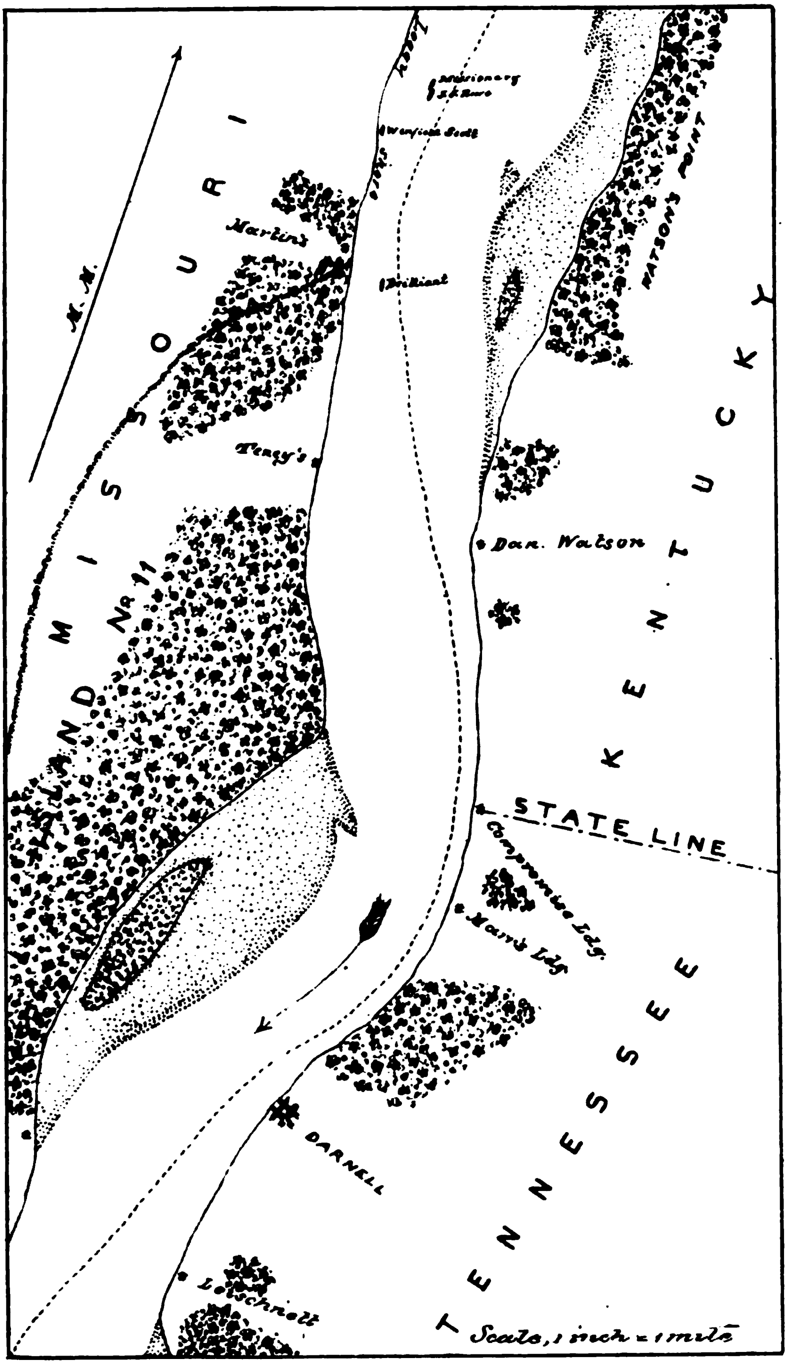

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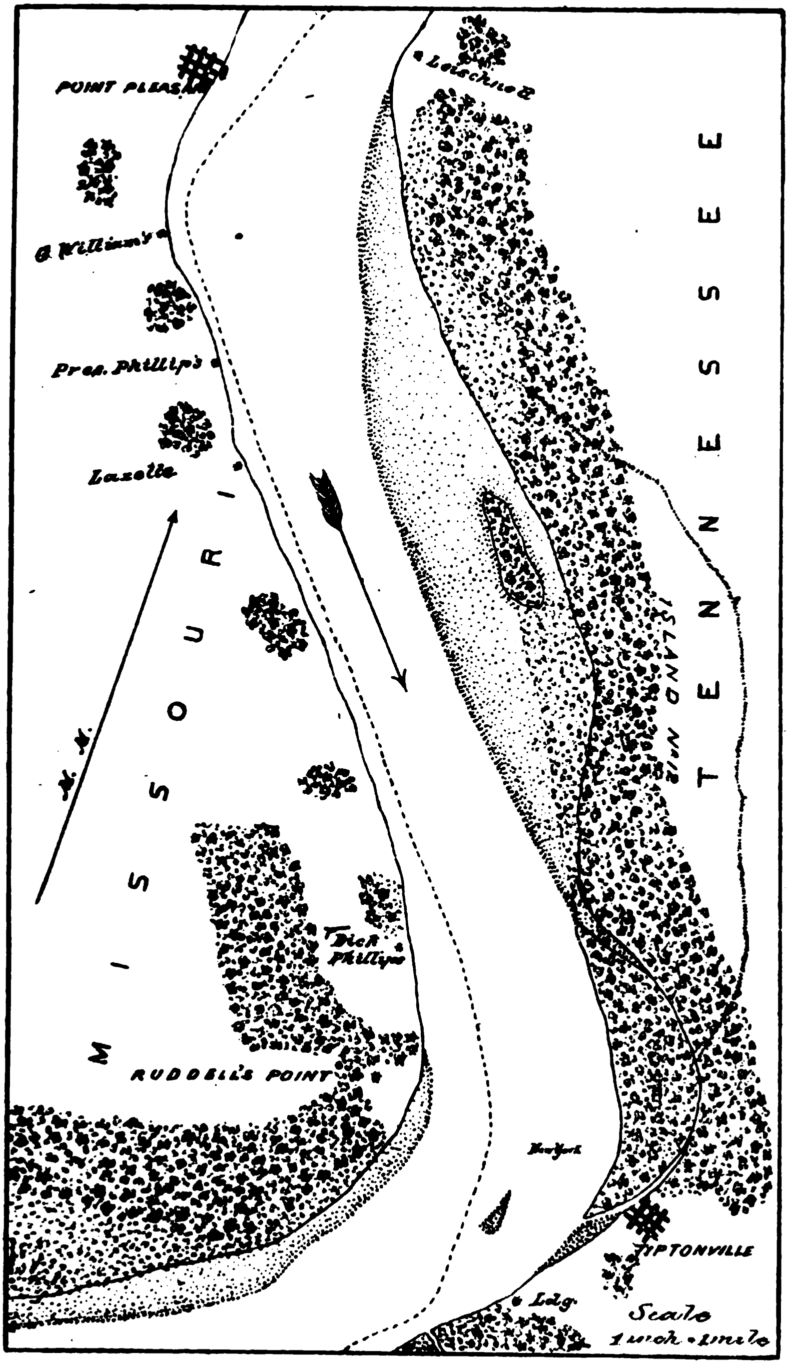

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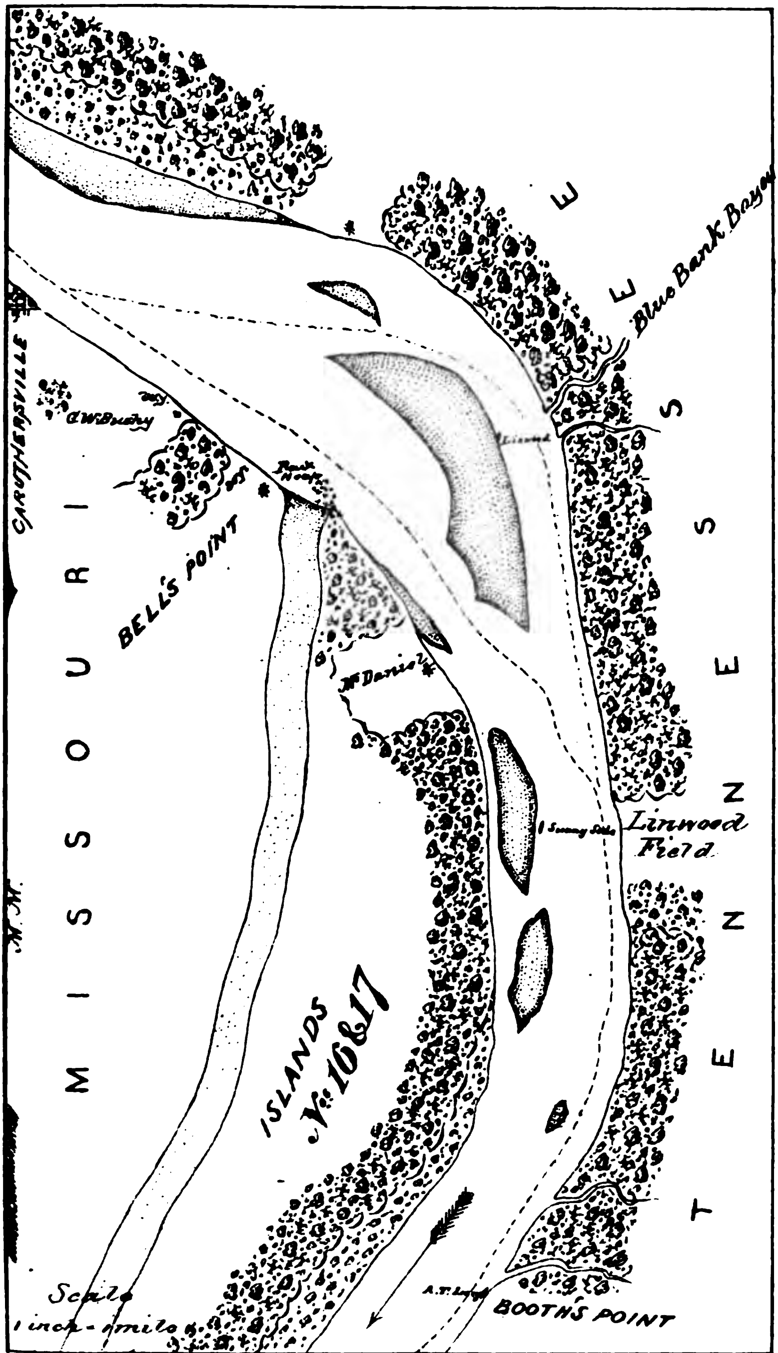

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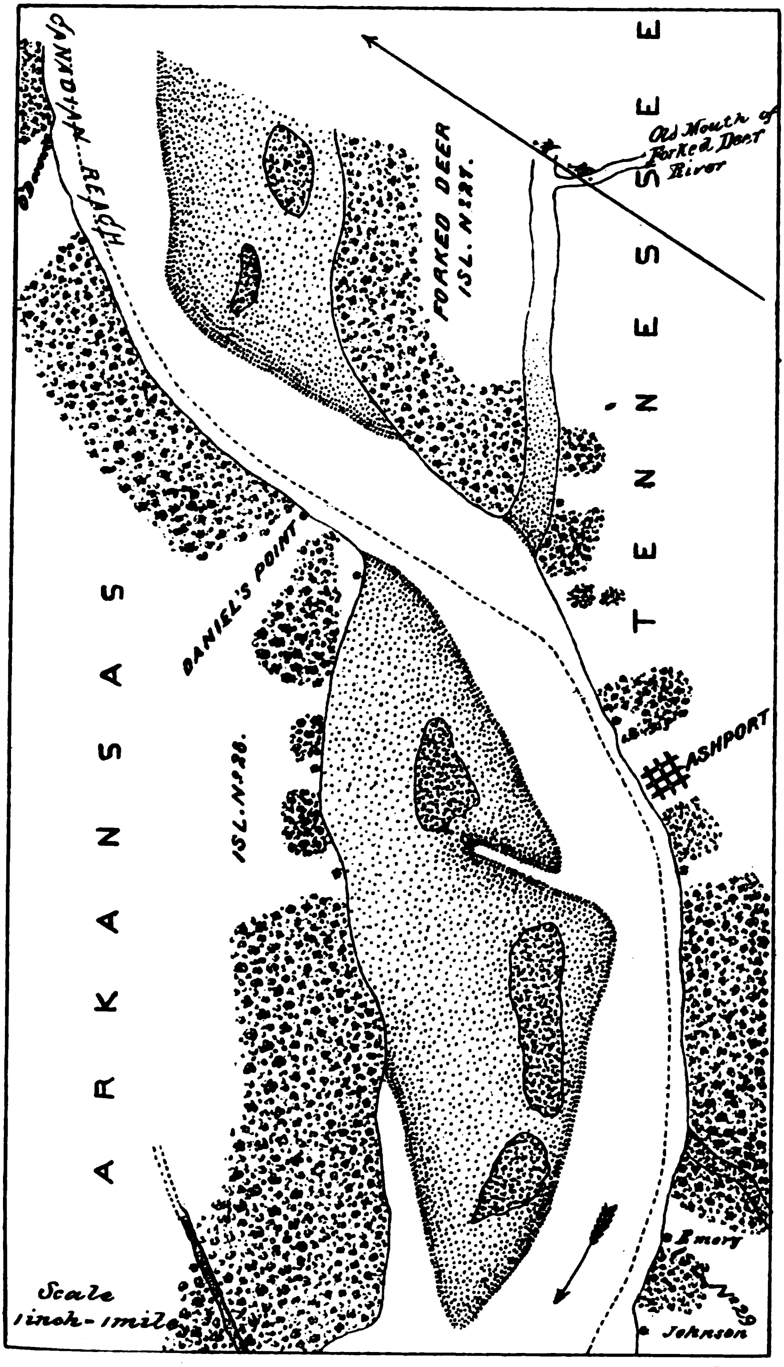

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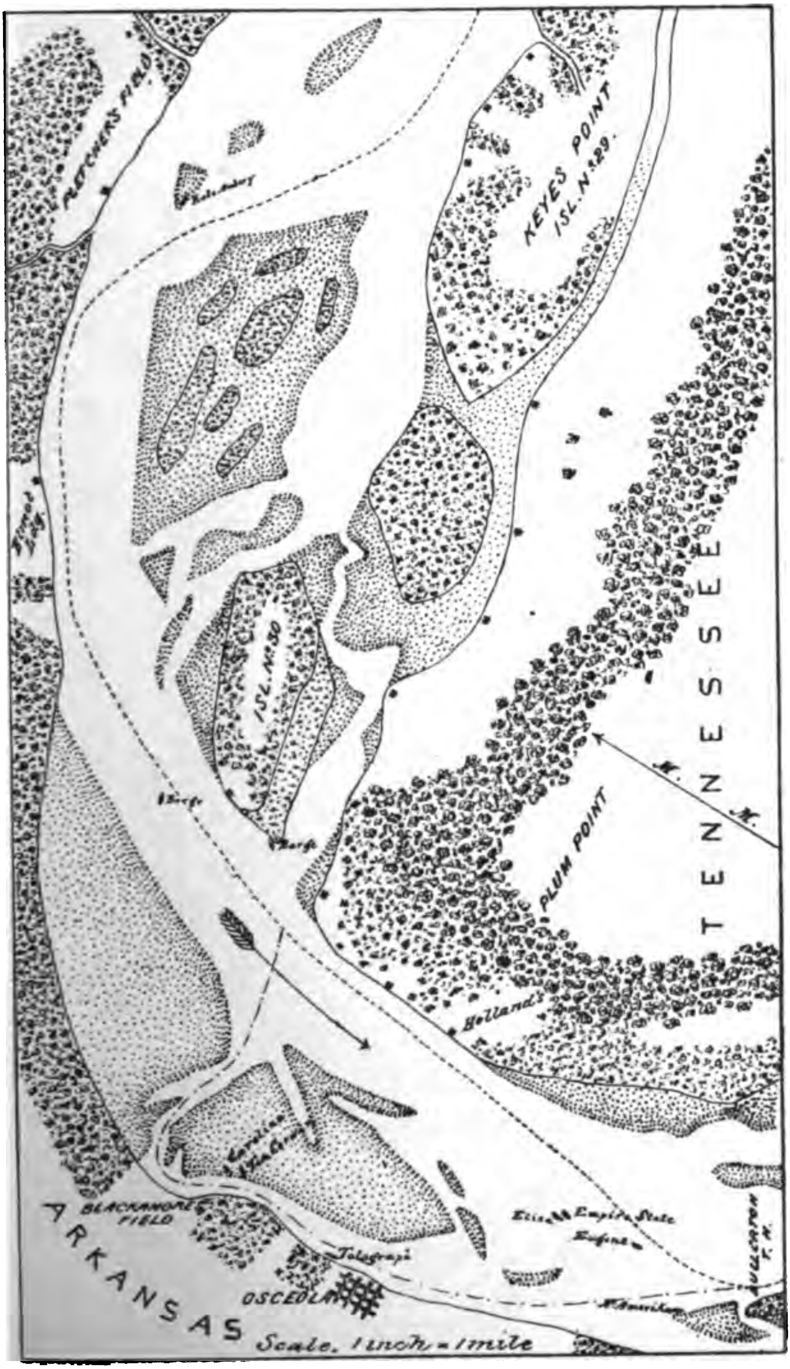

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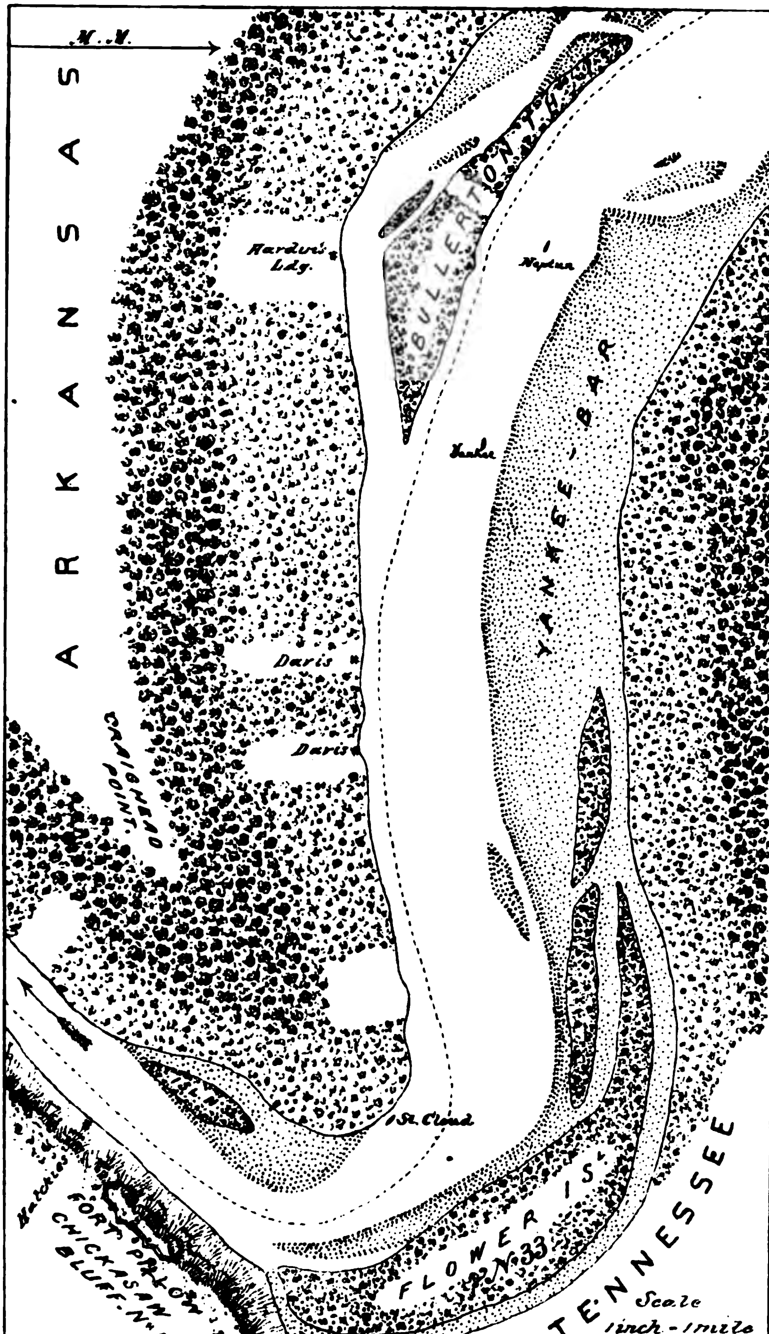

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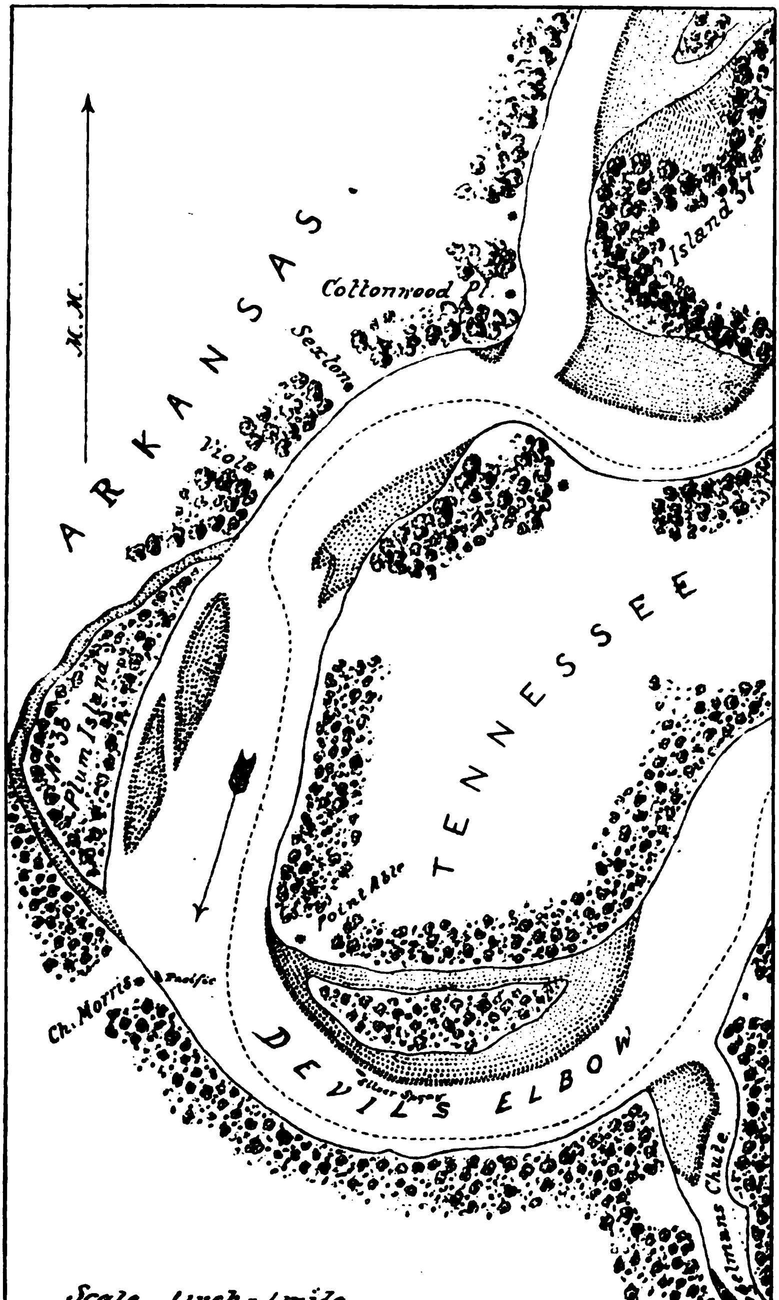

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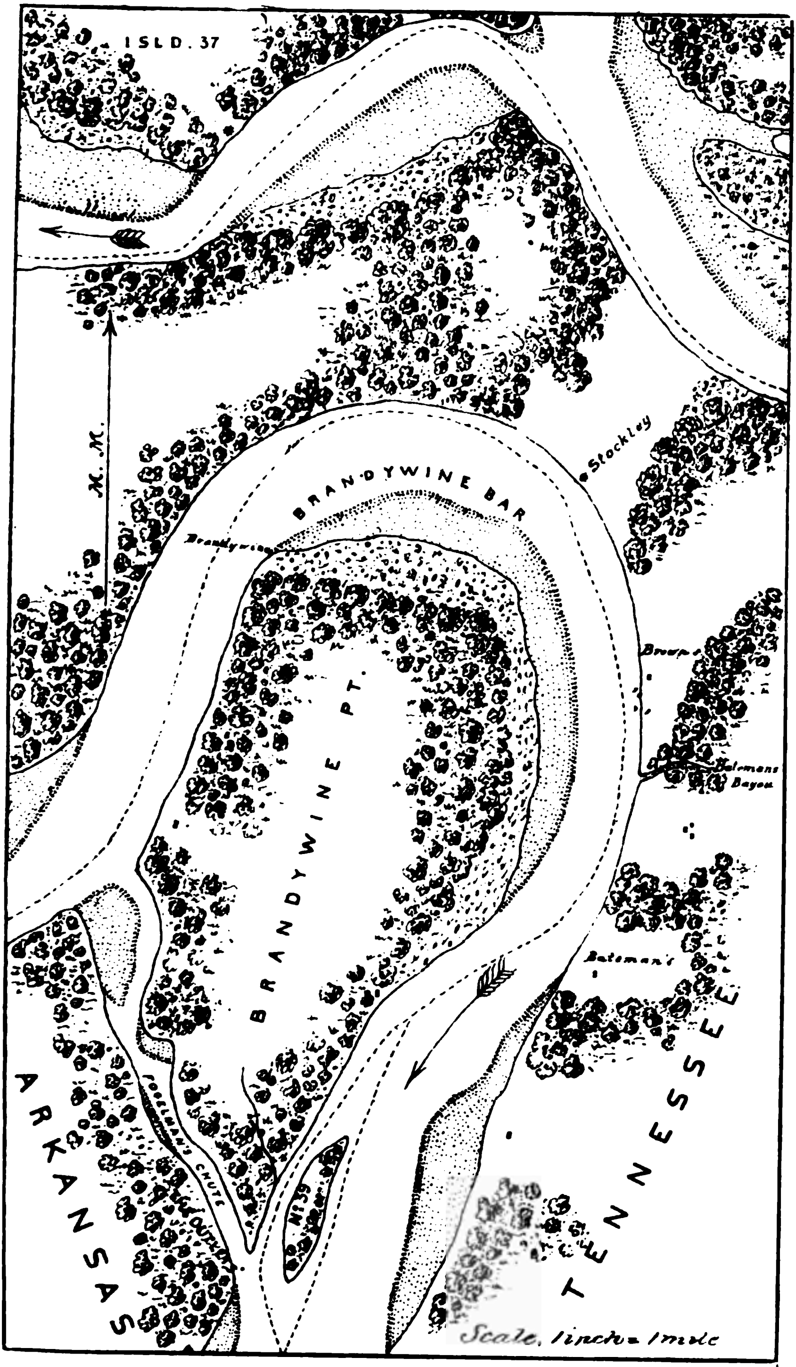

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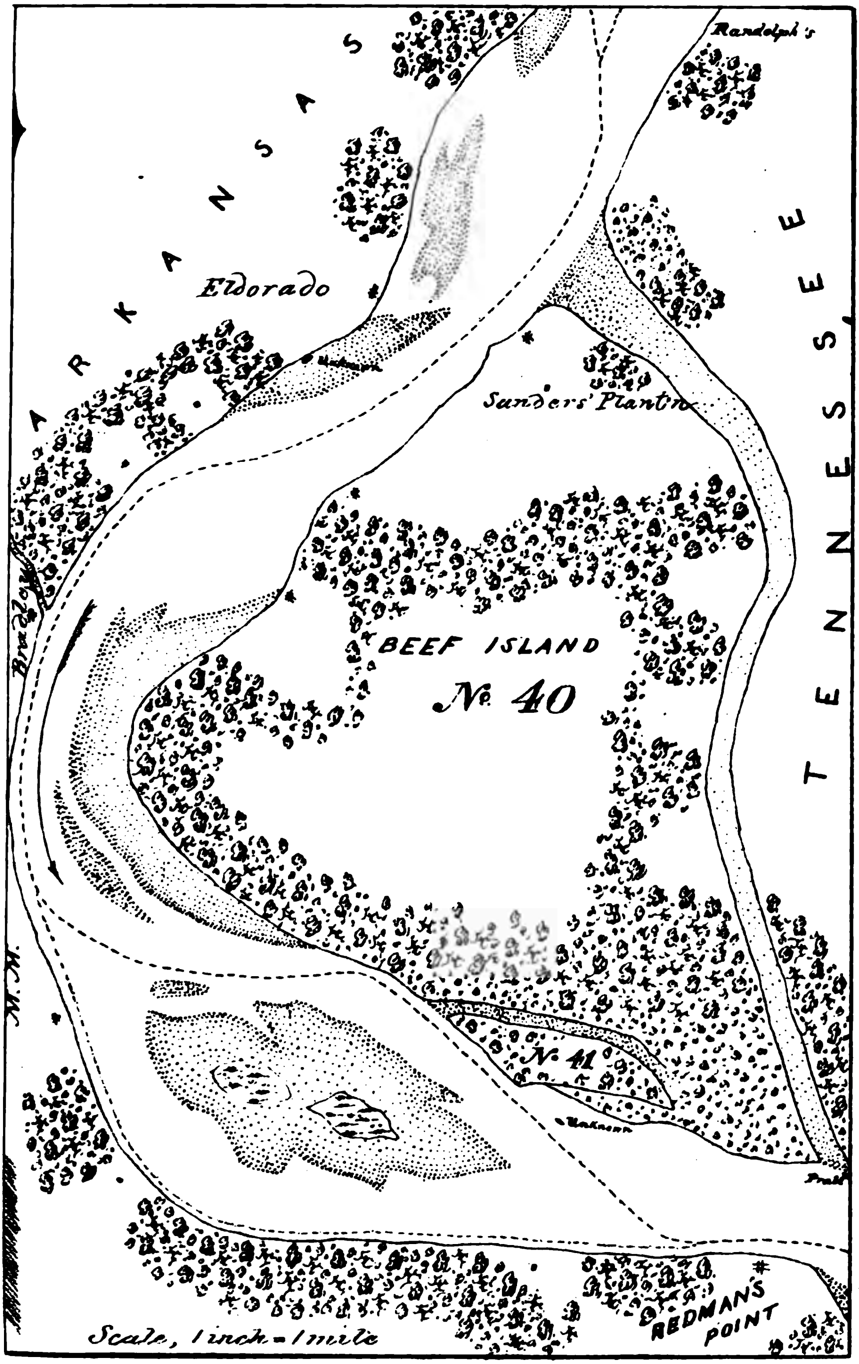

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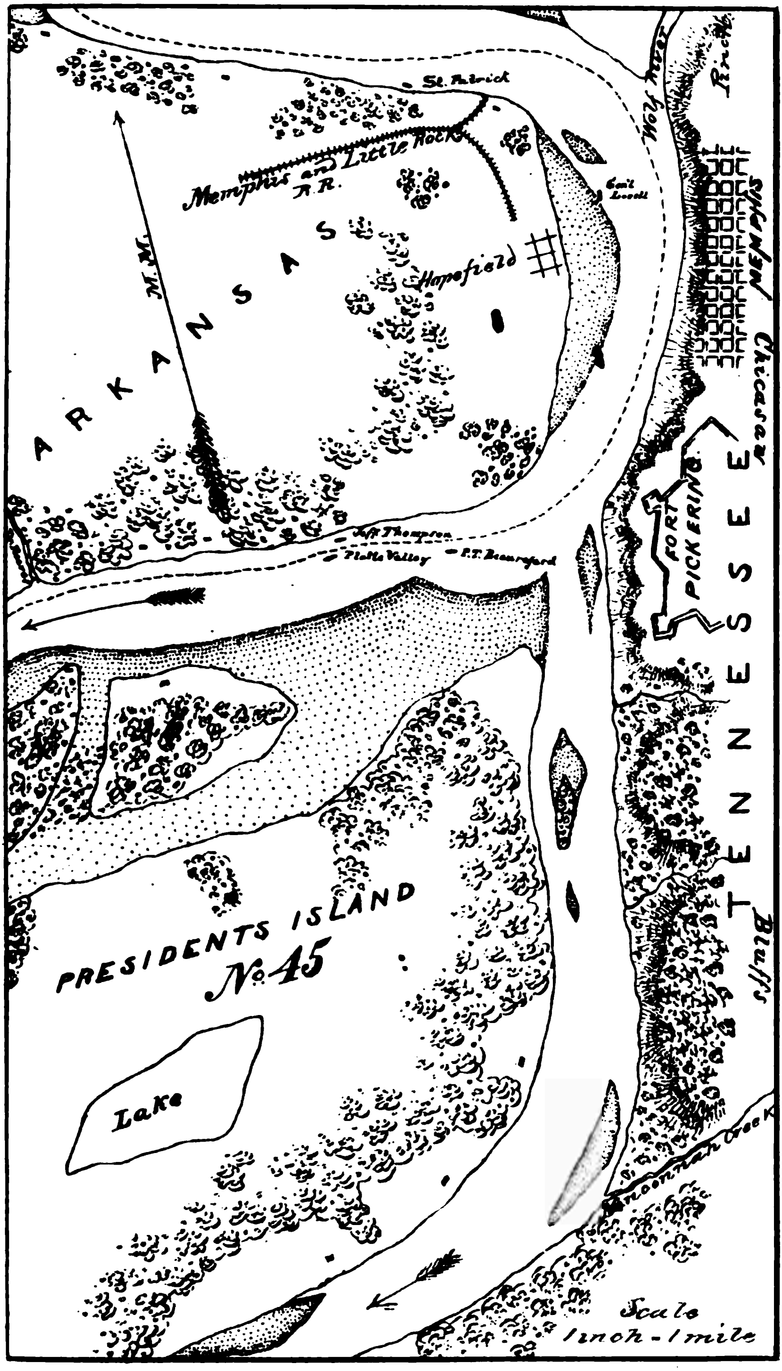

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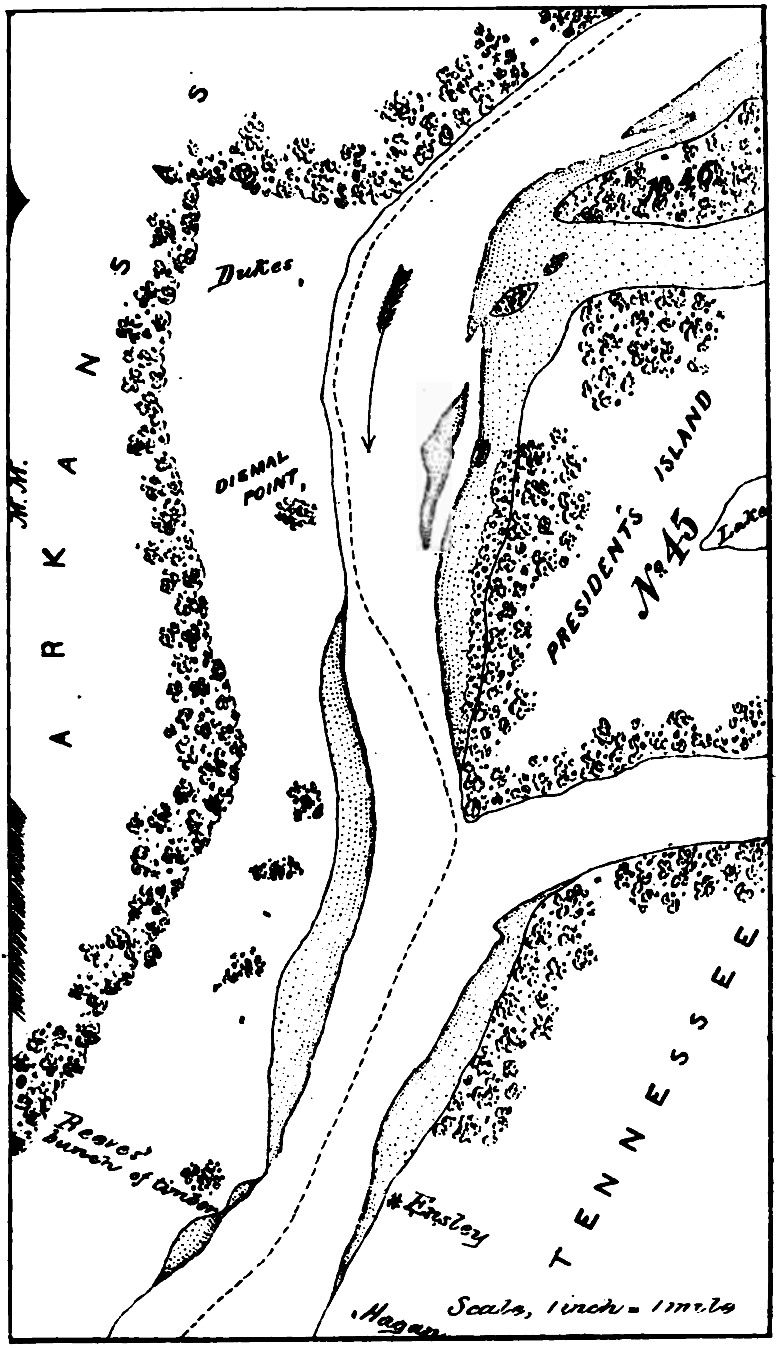

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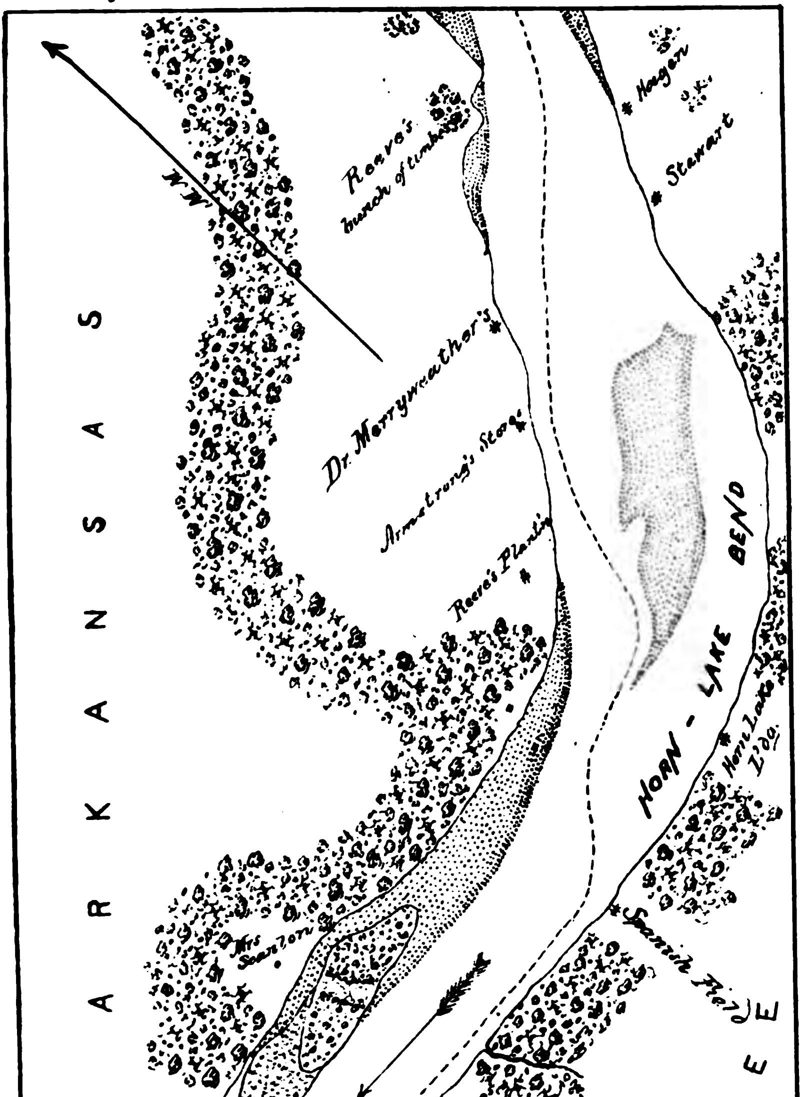

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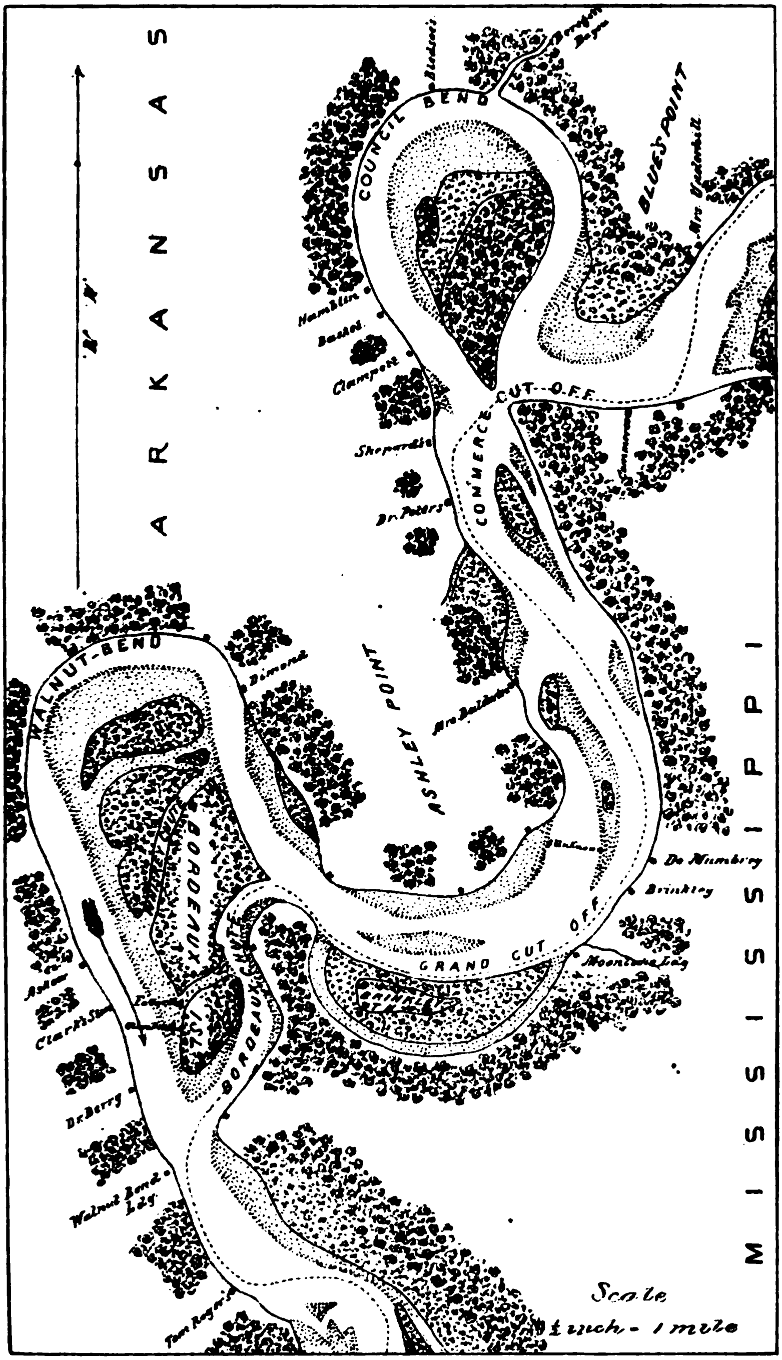

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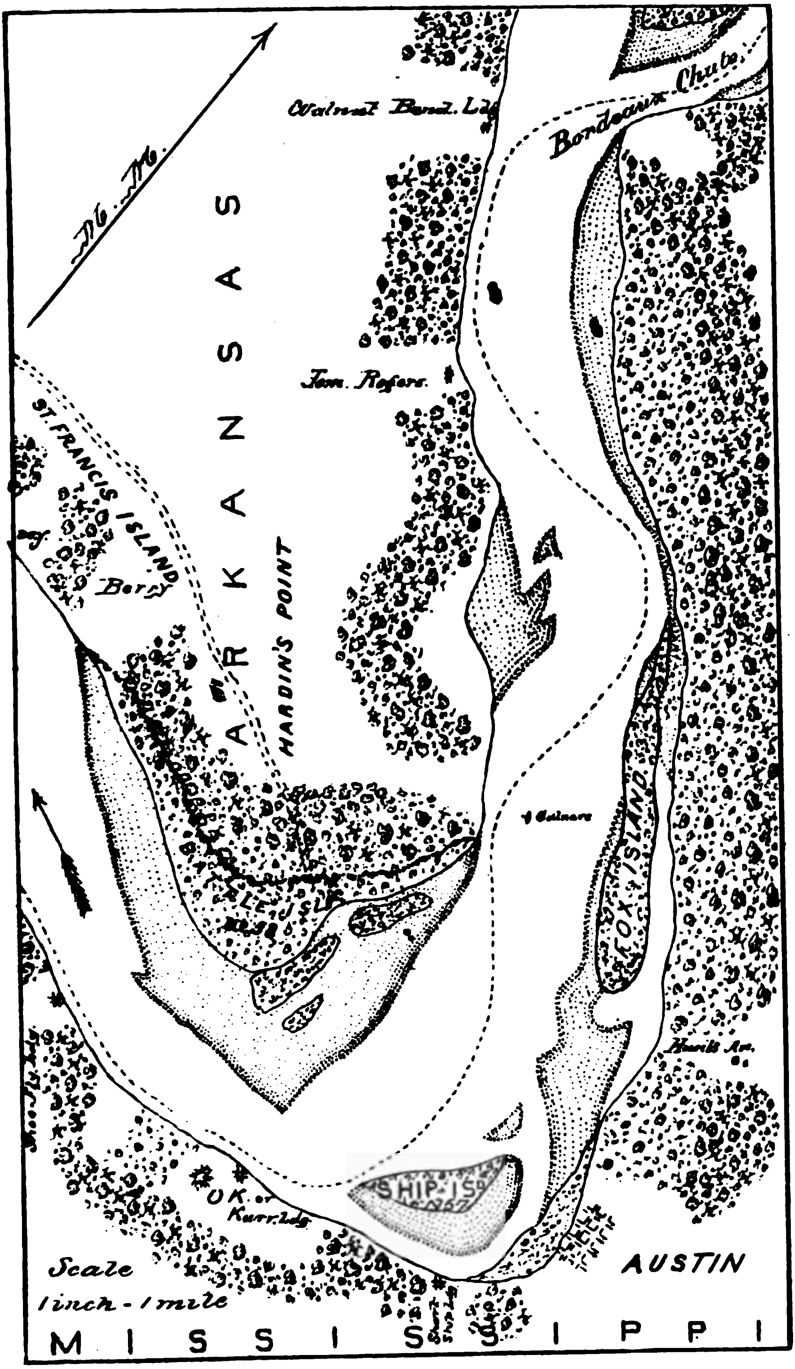

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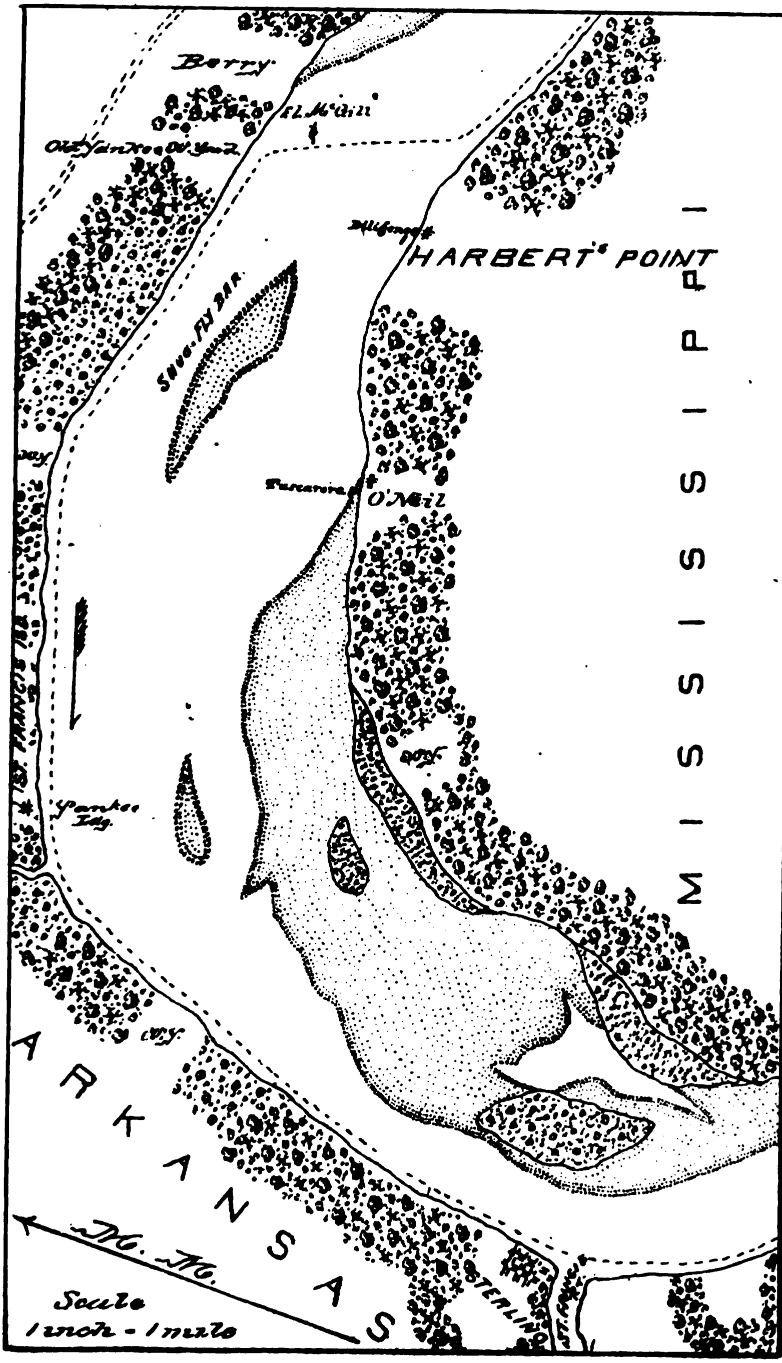

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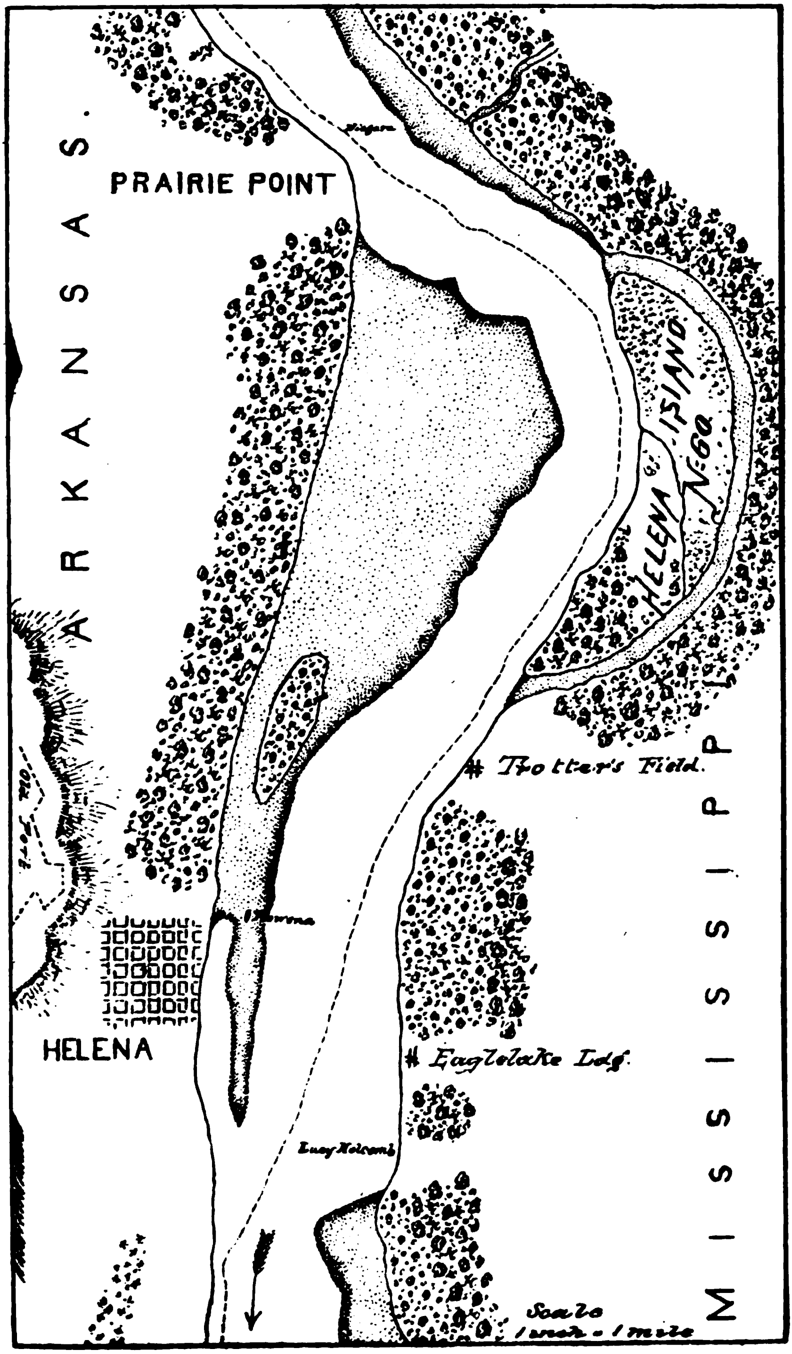

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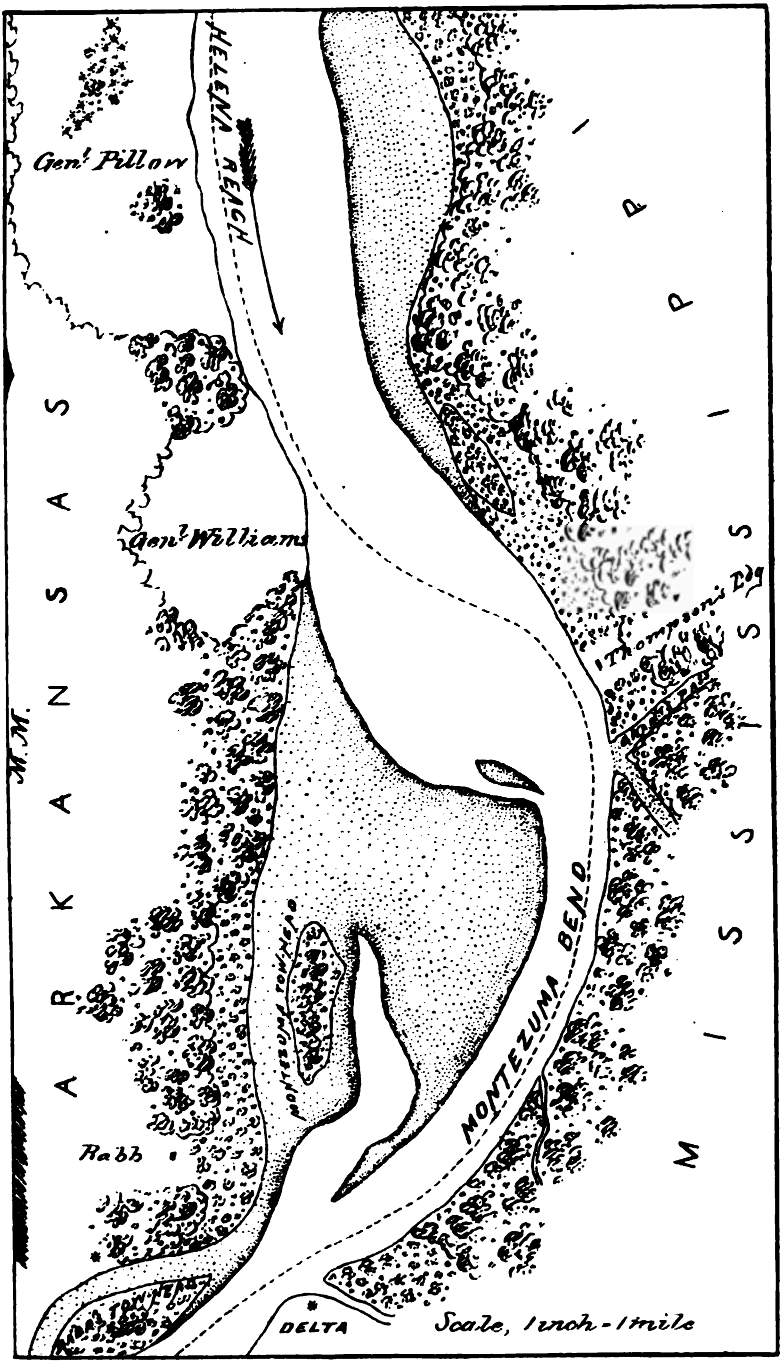

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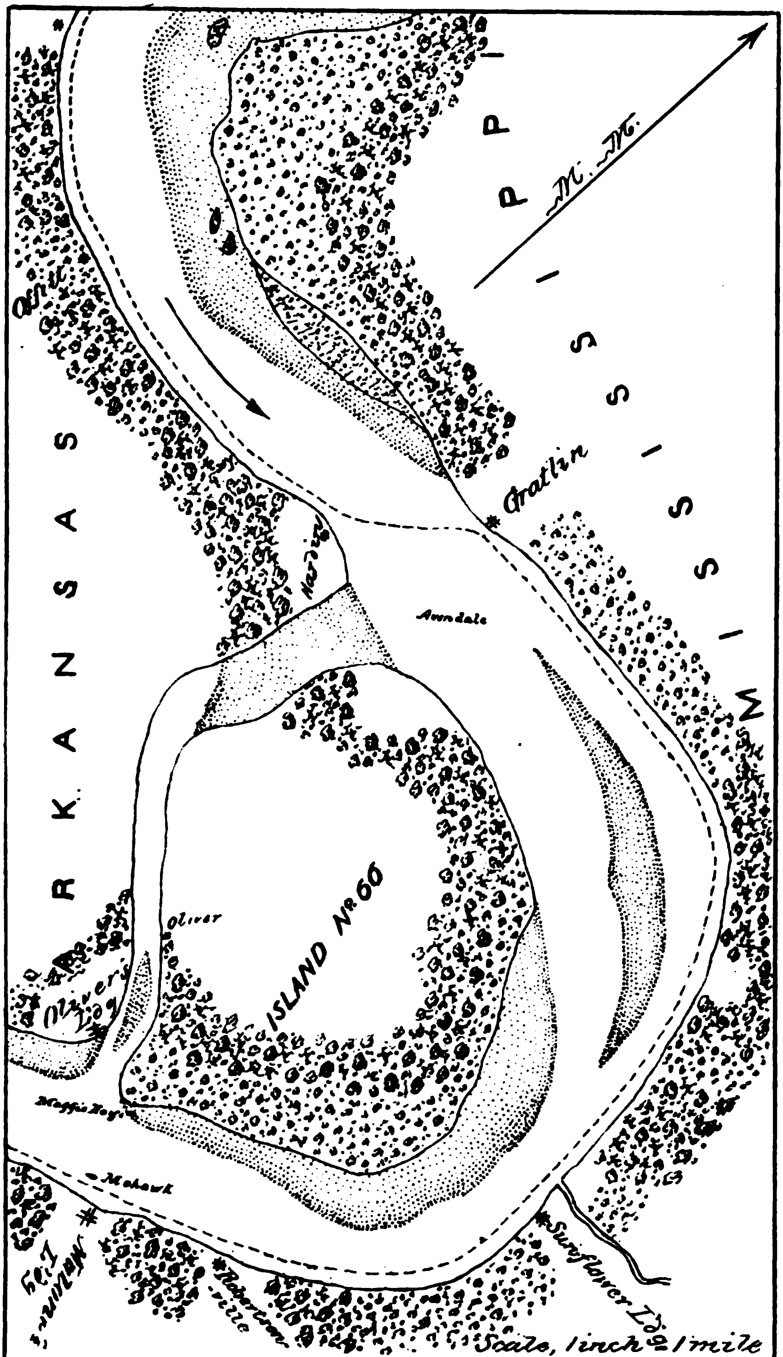

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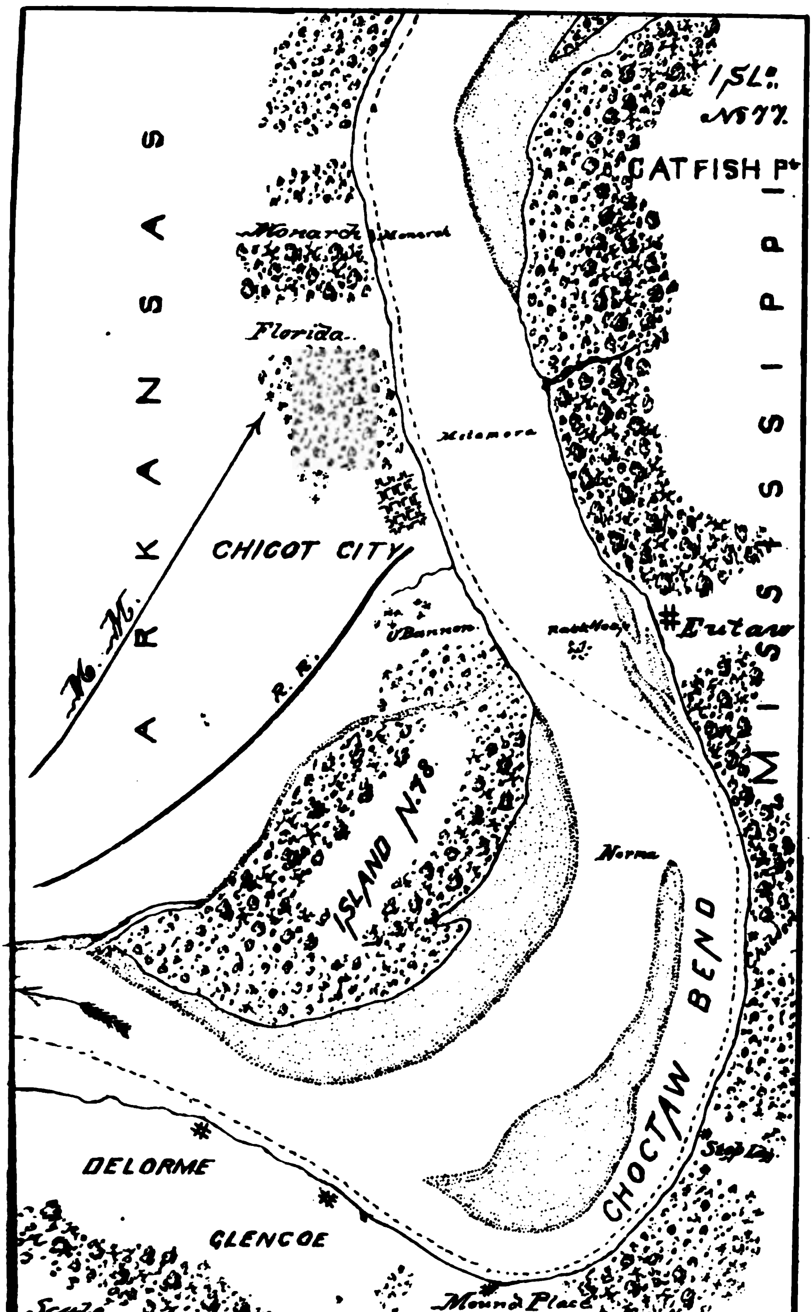

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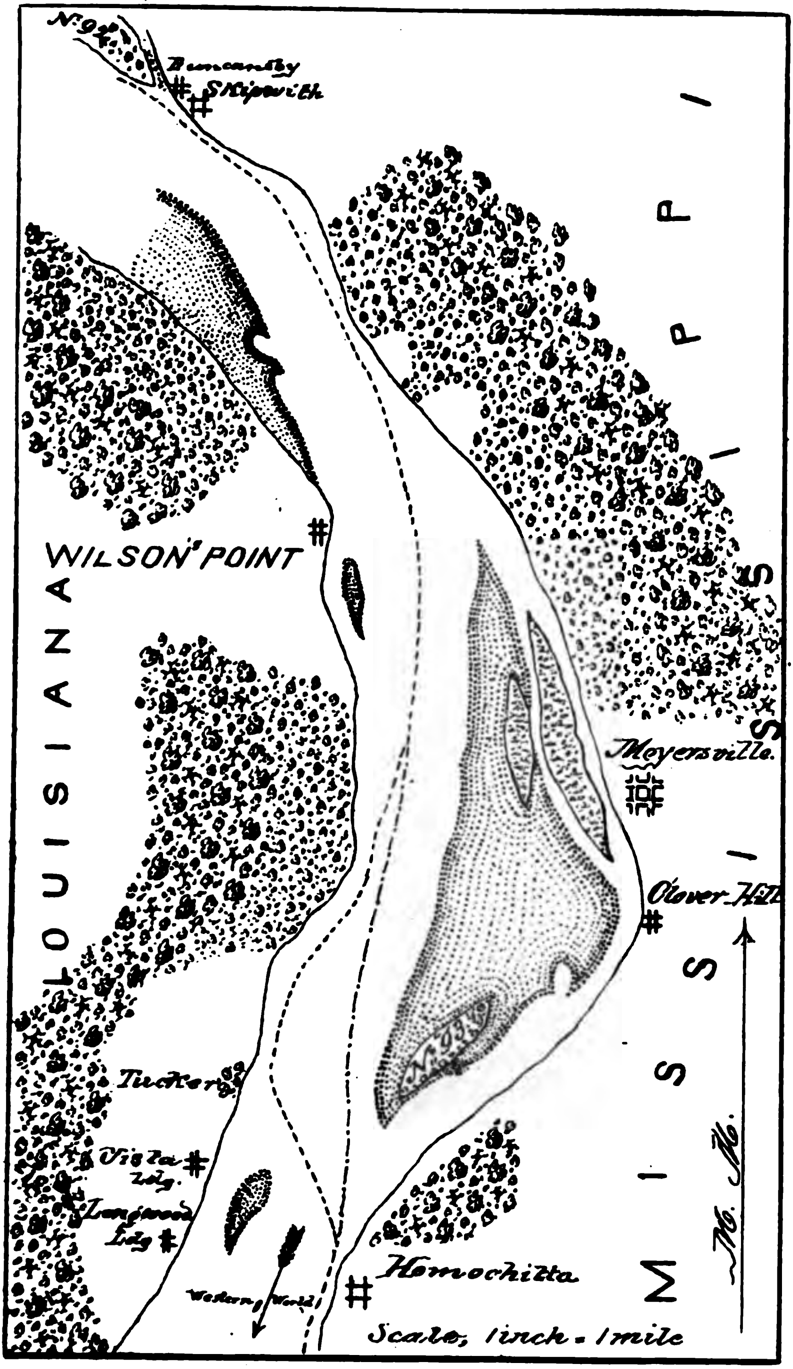

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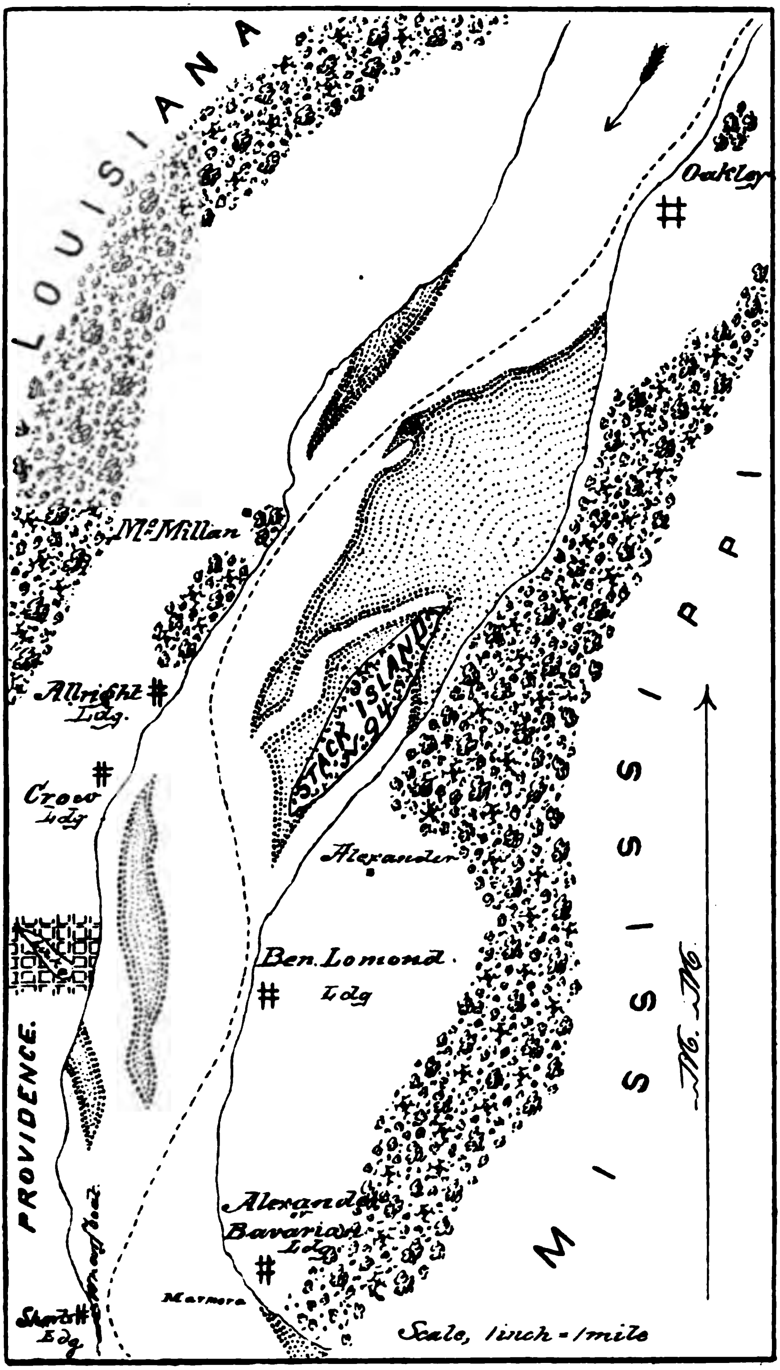

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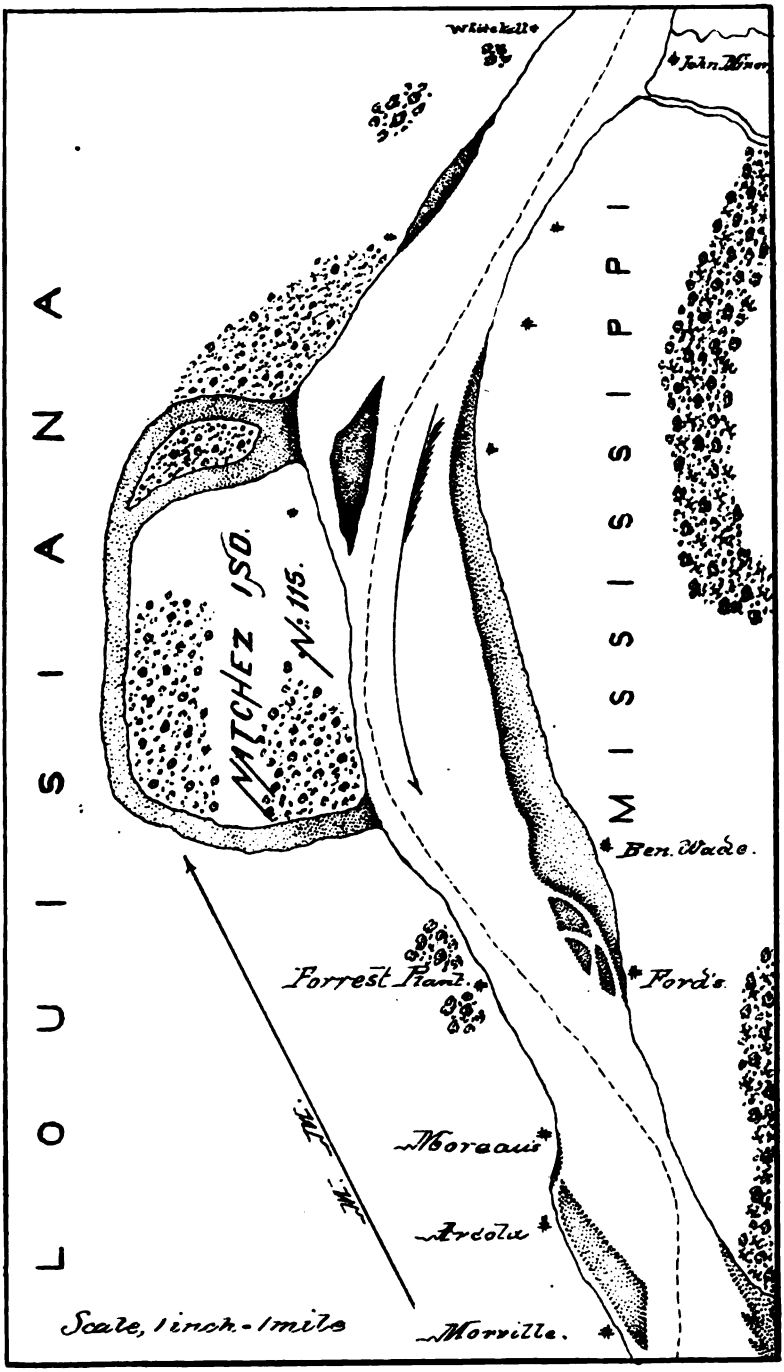

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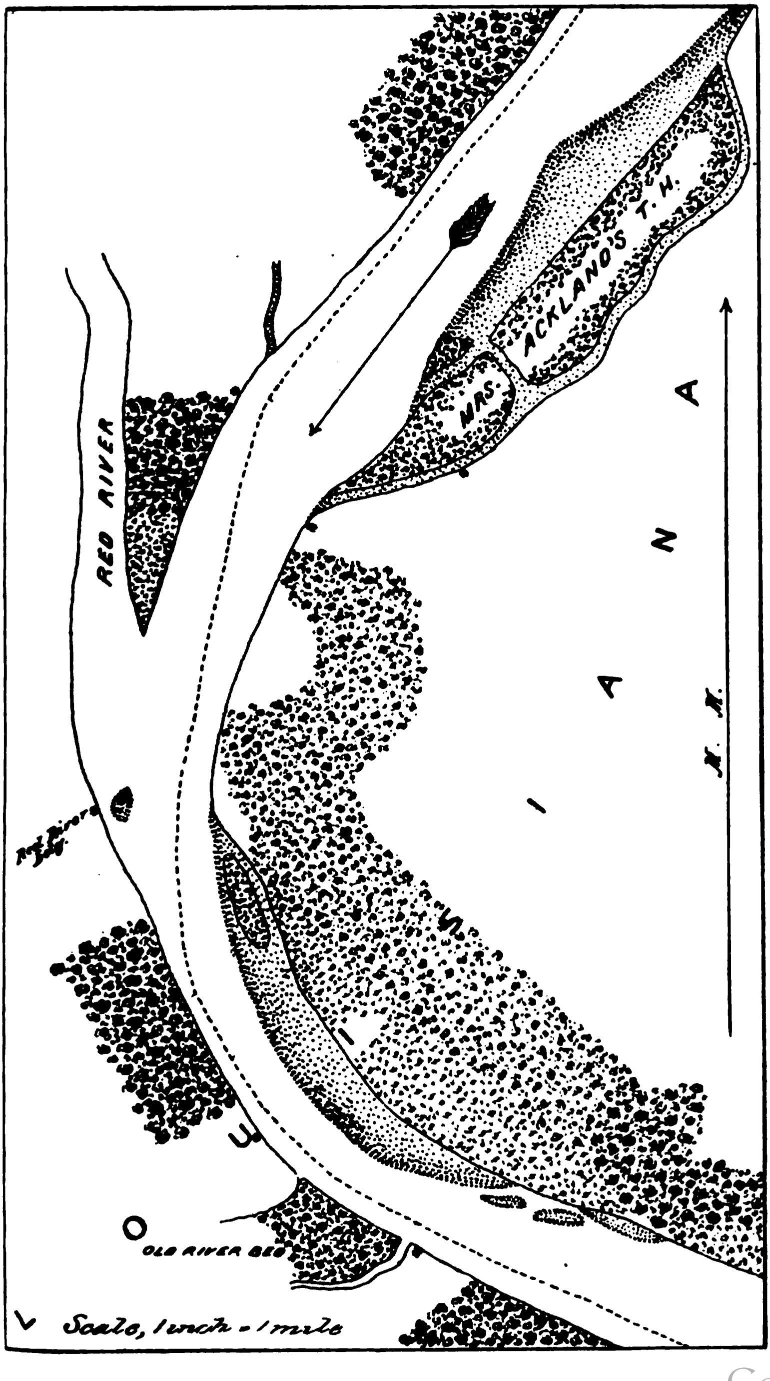


It appears that the object of this survey is to secure the greatest amount of exact information in relation to the improvement, and to procure data for accurate estimates of cost.

The survey of the Wisconsin River, made under direction of Major Warren, in 1867, contains all the information bearing upon this matter, so far as a survey can determine it. The changes that have taken place in the river are of such a character as not to affect the question of cost.

The experience gained by our operations during the past three years will enable me to make accurate estimates for the improvement of this river.

Partial surveys have been made of the Fox River, which were necessary in order to carry on the work of improvement. I have a detailed survey of a portion of the Upper Fox. There are portions of the route which do not require any detailed survey for purposes of estimates, as, for example, the lakes Buffalo, Apuckuway, Butte de Mort, and Winnebago, and portions of the rivers where there is sufficient depth of water for navigation at all times.

I propose, therefore, to confine the survey to such portions of the river as require to be improved which are necessary in the progress of the work, and which will furnish all the information desired by the Senate Committee on Transportation.

These surveys will show plans of the river with soundings, frequent cross-sections, and a profile showing the declivity of the stream.

The variations in the water-level will also be determined. Such surveys of the banks and adjoining country will be made as are necessary to determine amount of flowage caused by our works.

To do this work, I would request authority to employ an additional assistant at $150 per month.

In conducting this survey in connection with the work of improvement, the cost will be reduced and cannot exceed the amount authorized, viz, $10,000.

I am, general, very respectfully, your obedient servant,

D. C. HOUSTON,
Major of Engineers, U. S. A.

Brig. Gen. A. A. HUMPHREYS,
Chief of Engineers, U. S. A.

This project was approved, and the examinations and surveys have been completed. It will take some time to complete the maps of the survey, but I am able to submit revised estimates for carrying out the plan of improvement which has been set forth in previous reports. This plan consists in completing the system of slack-water navigation on the Fox River and the improvement of the Wisconsin River by confining the channel by means of wing-dams. The estimates contemplate replacing ultimately *all* the old locks and dams on the Fox River by permanent works, the locks to be of stone masonry.

The estimates submitted are in excess of former estimates; for the reason that they contemplate the rebuilding of *all* the old works, some of which will last for several years.

Tracings of the Wisconsin River, showing work done and proposed, old channel and present channel, also plan of canal for connecting the Wisconsin River with the Mississippi, are in preparation.

Owing to the character of the bar at the mouth of the Wisconsin, it is considered that the most economical and reliable method of connecting the navigation of the two rivers is by a short canal.

The maps giving the results of the surveys and examinations during the past season will be forwarded as soon as completed.

The total estimate for completing this improvement is $3,599,105. The amount that can be advantageously expended during the next fiscal year is $750,000.

I am, general, very respectfully, your obedient servant,

D. C. HOUSTON,
Major of Engineers, U. S. A.

Brig. Gen. A. A. HUMPHREYS,
Chief of Engineers U. S. A.

ESTIMATED COST OF IMPROVING THE LOWER FOX RIVER, WISCONSIN.

PART I.

Works of construction:

16 locks (cut-stone), at $50,000 each		$800,000

These works to replace existing works, as follows:

1 at Depere.
1 at Little Kaukauna.
5 at Kaukauna.
3 at Little Chute.
1 at The Cedars.
4 at Appleton.
1 at Menasha.

7 dams.

These are designed to replace existing works; location and estimated cost of each as follows:

1 at Depere	$45,000	
1 at Little Kaukauna	25,000	
1 at Rapide Croche	20,000	
1 at Little Chute	20,000	
1 at The Cedars	25,000	
1 at Appleton	15,000	
1 at Menasha	15,000	
		165,000
Total locks and dams, Lower Fox		965,000

PART II.

Dredging, rock-excavation, canal, &c.:

137,000 cubic yards dredging, at 20 cents	$27,400

Distributed as follows:

4,500 cubic yards, Depere to Little Kaukauna.
8,500 cubic yards, Little Kaukauna to Rapide Croche.
4,500 cubic yards, Rapide Croche to Kaukauna.
20,000 cubic yards, Kaukauna to Little Chute.
9,500 cubic yards, Little Chute to Appleton.
50,000 cubic yards, Appleton to Menasha.
40,000 cubic yards, Menasha to Oshkosh

33,500 cubic yards rock-excavation, at $2	67,000

Distributed as follows:

11,000 cubic yards at Depere.
8,500 cubic yards at Kaukauna.
3,500 cubic yards at Little Chute.
10,500 cubic yards at Menasha.

Repairing and raising canal-banks	40,000
Total dredging, canal-banks, &c., Lower Fox	134,400

Recapitulation—Lower Fox.

For 16 locks and 7 dams	$965,000
For 170,500 cubic yards excavation, and repairing canal-banks	134,400
Total Lower Fox	1,099,400

ESTIMATED COST OF IMPROVING THE UPPER FOX RIVER, WISCONSIN.

PART I.

Works of construction:

9 locks (cut-stone), at $50,000 each	$450,000

Of these, five will be new works and four to replace existing locks, as follows:

1 near Eureka } New.
1 near Berlin } New.
1 near White River } New.
1 near Princeton } New.
1 near Grand River } New.
1 at Montello.
1 at Governor's Bend.
2 at Portage Canal.

7 dams, at $12,000 each	$84,008
Five of these to be built in connection with the new locks; two to replace dams at Montello and Governor's Bend.	
Total for locks and dams	534,000

PART II.

Dredging, cuts-off, canals, &c.:	
5,000,000 cubic yards excavation, at 20 cents	$1,000,000
For widening, deepening, and revetting the upper portions of Portage Canal	35,000
Total dredging, cuts-off, &c	1,035,000

Recapitulation—Upper Fox.

For 9 locks and 7 dams	$534,000
For 5,000,000 cubic yards dredging	1,000,000
For upper section Portage Canal	35,000
Total Upper Fox	1,569,000

SUMMARY OF ESTIMATES.—COST OF IMPROVING THE FOX RIVER, WISCONSIN.

Lower Fox.		
For 16 locks and 7 dams	$965,000	
For 170,500 cubic yards excavation	94,400	
For repairing canal-banks	40,000	
Total for Lower Fox		$1,099,400
Upper Fox.		
For 9 locks and 7 dams	$534,000	
For 5,000,000 cubic yards excavation	1,000,000	
For upper section Portage Canal	35,000	
Total for Upper Fox		1,569,000
Grand total Fox River		2,668,400

The dredging is to be done by machines owned and operated by the government.

ESTIMATED COST OF COMPLETING THE IMPROVEMENT OT THE WISCONSIN RIVER.

96,141 running feet of wing-dams, at $5	$480,705
Bank-protection	50,000
Canal connecting Wisconsin River near its mouth with the Mississippi	400,000
	930,705

RECAPITULATION FOX AND WISCONSIN RIVERS.

Fox River	$2,668,400
Wisconsin River	930,705
	3,599,105

C C 7.

SECOND SUBDIVISION OF THE NORTHERN TRANSPORTATION-ROUTE—HENNEPIN CANAL.

REPORT OF COLONEL J. N. MACOMB, CORPS OF ENGINEERS.

ROCK ISLAND, ILL., *January* 25, 1875.

GENERAL: I have the honor to present herewith the report of Mr. F. C. Doran, assistant engineer, who was charged by me with the duty of

making the surveys and estimates for the Hennepin Canal route, and particularly for the extension to Chicago.

In considering the Hennepin Canal as a part of the water-communication desired for connecting some point of the Mississippi River, near Rock Island, with Lake Michigan, at Chicago, it appears that the basin at Hennepin is about 100 feet below the level of the Mississippi River in the vicinity of Rock Island, and nearly 140 feet below the level of Lake Michigan.

A survey was made to ascertain if the lockage required to pass this depression of the Hennepin basin could be avoided. This survey led to the conclusion that, on every account, the Hennepin Canal and Upper Illinois River, and enlarged canal from Joliet to Chicago, will afford the best through route for navigation between the Mississippi River and Lake Michigan that can be secured in this vicinity.

In the estimates originally made for a commercial canal, due consideration was not given to the necessity of having the locks large enough to pass such barges as are used for freight on the Upper Mississippi, and I therefore caused estimates to be prepared for locks of 170 feet in length and 30 feet in width, which will increase the estimate for the Hennepin Canal, or third division of the route, by some $641,284.

For the great end to be attained, of effecting a transfer of freight-barges from the Mississippi, without breaking bulk until reaching the elevators at Chicago, it would be useless to consider locks of any smaller dimensions than those above indicated.

The most important and costly part of the route across this section of the country is the portion between Hennepin and Chicago; for this part is essential as affording an eastern outlet for the Hennepin Canal traffic and for perfecting the navigation to Chicago from the Lower Mississippi River through the Illinois River, which is now being improved for steamboat-navigation from the Hennepin Basin down to the Mississippi River. Indeed, the Hennepin Canal, without the improvement of the Upper Illinois River and the enlargement of the eastern portion of the Illinois and Michigan Canal, would be useless as an outlet for the freights of the Upper Mississippi River; and a careful consideration of the subject has shown that the improvement of the Upper Illinois River, to accord with the scheme of improvement now in progress for its lower portion, is greatly to be preferred as a measure of economy in its broadest sense, rather than to undertake the enlarging of the western portion of the Illinois and Michigan Canal lying between Joliet and the Hennepin Basin.

The improvement of the eastern portion of the Illinois and Michigan Canal involves the further cutting down of the summit-level and enlarging the water-way so as to afford an unfailing supply of water from Lake Michigan for the improved Illinois River.

It will be seen by the report of the assistant engineer that the estimate for the route, as above sketched out, for a navigable water-way from the Mississippi River, near Rock Island, to Chicago, on Lake Michigan, is	$19,780,535
To which should be added the amount of increase in estimate for locks of proper size on Hennepin Canal	641,284
Making a grand total of	20,421,819

All of which is respectfully submitted by your most obedient servant,

J. N. MACOMB,
Colonel of Engineers, U. S. A.

Brig. Gen. A. A. HUMPHREYS,
Chief of Engineers, U. S. A.

REPORT OF MR. F. C. DORAN, ASSISTANT ENGINEER.

ROCK ISLAND, ILL., *January* 9, 1875.

COLONEL: I have the honor to submit the following report upon the examination and survey of a route for a canal between Lake Michigan and the Mississippi River, together with the survey of a portion of the Illinois River. This survey having been committed to me, in obedience to your instructions, bearing date Rock Island, Ill., July 9, 1874, I proceeded to organize and equip a party for field-service. The whole time employed by the party in field operations was eighty-three days. Of this time, five weeks, or a little more than one month, were spent in examinations and surveys of a direct line joining the lake and the Mississippi; the remaining six weeks were devoted to the survey of the Illinois and Michigan Canal and a part of the Illinois River. These surveys have traversed quite a large expanse of country, having, within the time specified, examined and surveyed lines to the extent of two hundred and twenty-five miles.

As will be seen, this report is intended to embrace a statement of facts in relation to the Illinois and Michigan Canal and Illinois River as they at present exist, with a description of the several improvements and enlargements proposed, together with a detailed tabular statement showing the estimated cost of the improvement throughout the entire line, extending from the lake to the Mississippi.

I would preface with a condensed statement of the results of my examination of the direct route first mentioned. One of the principal objects to be attained by the survey was to obtain data and accurate notes of the topography of the country lying between Lake Michigan on the east and the great bend of the Mississippi on the west, and from the information obtained, to determine as to the practicability of a plan for a water-route to connect the lake and the river at the points specified.

In compliance with your order, I commenced the survey of the proposed line at the city of Chicago, August 24, proceeding thence in a west and northwest direction, surmounting the dividing ridge between the lake and Fox River, crossing the valley of this stream and ascending the valley of Ferson's Creek, reaching the summit and passing through a depression in the ridge dividing the valleys of the Fox and Rock Rivers at a point near the western boundary of Kane County.

The topography of the country is such that it would necessitate the location of the summit-level at an elevation of 250 feet above the lake.

From this point the line followed the course of the south branch of the Kishwaukee River, descending with it to the valley of the Rock River. At this time it was found that the facts developed during the survey furnished sufficient evidence to demonstrate conclusively the impracticability of the route as proposed; and, the object of the survey having been attained, I suspended further operations, and terminated the survey of this line at a point near New Milford, Winnebago County, September 30, the terminal point being eighty and five-tenths miles from the lake at Chicago.

As my weekly reports to you contain detailed information as to the physical characteristics of the country and its adaptability to the purposes in view, I will not revert to them again, but will proceed with the report of surveys of the other lines previously referred to.

The survey of the Illinois and Michigan Canal and the Des Plaines and Illinois Rivers was commenced October 5, at the old lock in the canal at Chicago, and was continued along the canal and river to where the canal unites with the river at La Salle, suspending field-work at this point November 10. The entire distance, as measured along the canal and river, is 99.28 miles. Of this distance 36.53 miles is canal and 62.75 miles river line; 32.65 miles of the former lie between Chicago and Joliet; the first 29.55 miles of this constituting the summit-level of the canal. The lockage on this route is all descending from the lake, and amounts to an aggregate of 145.6 feet, as determined by our levels.

In order to carry out your instructions, a thorough reconnaissance was made of the country, extending from the lake to a point in the present line of canal some eighteen miles out from the lake, known as Sag-Ridge, including the Calumet Feeder route. But as these examinations failed to discover any route possessing as favorable features as the existing line of canal presented, and as this canal had been originally located with great care, it was determined to adhere to the present alignment.

The original proposition in regard to the enlargement of this work to dimensions corresponding to those adopted on the Lower Illinois River improvement has been kept in view, and all quantities and the cost of the entire work have been calculated in accordance therewith. The dimensions there adopted, as you are aware, are as follows, viz, lock-chamber, 350 by 75 feet. A restriction to those dimensions is rendered necessary in order to produce a complete and homogeneous system of navigation between the lake and the great rivers of the West.

It is believed the proposed plan of enlargement of the Illinois and Michigan Canal, combined with the improvement of the river and the construction of the Hennepin Canal, will, when completed, meet the wants of the commercial world, affording as well facilities for the passage of war-vessels from the rivers to the lakes, or *vice versa*.

The plan of locks adopted, although identical in size of chamber with those constructed on the lower part of the Illinois River, would differ somewhat in detail of construction and in the material employed in the gates.

The general features of the country along the line of canal and river are so well known to you that any minute description in this report would seem superfluous. Yet, while refraining from such description, I deem it necessary to call your attention to the geology of the district, as it is believed that in no other route between the lakes and the Mississippi River are the natural elements used in construction found in such abundance and in such accessible positions. In fact, the geological features of this route render it pre-eminent in the matter of economy of construction.

In view of the fact that different styles of navigation are proposed on different parts of the route, I have divided it into three divisions. The first division consists of independent canal from Chicago to Joliet; the second division, extending from Joliet to La Salle, will consist of an improvement of the river by locks and dams, being virtually a continuation of the slack water navigation projected in the river below La Salle. The third division consists of independent canal, corresponding to the line adopted and known as the Hennepin Canal, extending from the Illinois to the Mississippi River.

As it is proposed to draw the supply of water f. r the canal and river from the lake, all elevations are referred to the low-water plane of Lake Michigan; and as the course of the canal is laid down on the maps, it will not be necessary to advert to that here.

First division.—The canal commences with an average water-section equal to 448 square feet, with a variable depth of from 6 to 8 feet of water. As will be noticed, its course coincides with a right line for a distance of seven and a half miles, at which point it is deflected to the south and continues parallel to the valley of the Des Plaines River until it unites with the latter at Joliet. The physical difficulties to be overcome along this line are of an ordinary character, being such as are common to works of this class in almost all parts of the country.

The first fourteen and a half miles of canal are excavated through a compact blue clay to an average depth of 16 feet. On the latter half of the fifteenth mile rock-excavation begins, and, with the exception of a few short intervals, this material continues to exist along the line to a point below Joliet.

At Lockport a section of the valley of the Des Plaines River was taken, which will be shown on the sheets accompanying this report, from which it will be seen that the valley is a little more than one mile in width, with a thin drift of clay over the rock, the river-bed occupying at this point the central line of the valley.

As this had previously been designated as a favorable point at which to leave the canal for the river, I examined the valley with great care, and submit a section to show the superiority of the present location and the impracticability of any plan tending to a change in the direction mentioned.

As will be observed, the present channel is insignificant, the bottom of the river being but little below the general elevation of the valley; any channel of sufficient capacity to accommodate heavy vessels would, therefore, be expensive compared to the present line of improvement. One-half mile in advance of the point where the above section was taken, and 30.65 miles from Chicago, lock No. 1, of 12 feet lift, is met. One mile beyond, lock No. 2, of 10 feet lift, occurs; a reach of less than 1,000 feet brings us to lock No. 3, of 10.67 feet lift, and 1.46 miles from lock No. 3, a combined guard and lift lock connects the water in the third level with the surface of the pool produced by dam No. 1 in the Des Plaines River at Joliet. The canal continues eight-tenths of a mile, joining the river at a point six-tenths of a mile above dam No. 1, and 32.65 miles out from Chicago. The total lockage on this division is 34.7 feet.

Prior to the year 1872, the summit-level of the Illinois and Michigan Canal was some 8 feet above the standard level of Lake Michigan, and the quantity of water requisite to maintain navigation on the summit-level of the canal was supplied from Lake Calumet by a feeder and from the Chicago River by expensive pumping-machinery.

Some time during the year 1866 the board of public works of the city of Chicago entered into a contract with the State to cut down and reduce the summit-level of the canal to the elevation of the lake.

The object of this work on the part of the city authorities was to obtain an outlet for the south branch of the Chicago River; that being a receptacle for the sewerage of a large part of the city.

This contract was satisfied, the work completed, and navigation on the canal resumed July 18, 1872. The exertions and labors of the city to rid itself of a nuisance were not in vain; the residents of the city were relieved of a truly great evil, and the problem of securing a permanent and ample supply of water for the canal was practically solved.

Happy as such results were, the work, from its contracted dimensions, afforded only partial relief; and recent drainage improvements in the vicinity of the city have

proved quite detrimental to and interfered very seriously with the city's purposes and interests in respect to this work.

In view of the many benefits that would accrue to the city in case of a further enlargement of this canal, as contemplated, the question is believed to be pertinent, Will the city assume her portion of the cost of such enlargement?

One of the important duties of this survey was to determine accurately the volume of water to be drawn from the lake to maintain a depth of water in the river after it should be improved.

Experience on the summit-level of the canal, since it has been supplied from the lake, proves conclusively that the varying stages of water in the lake very materially affect navigation on this part of the canal. This fact is more noticeable during periods when the direction of the wind is parallel with the axis of the canal; the fluctuations in the elevation of the surface of the water being directly traceable to this cause.

As it was important to discover what relation this action of the wind bore to the volume of water discharged in different sections of the canal, I made a series of observations with that end in view. The results of these observations have not only answered as a check upon theoretical deductions, but have also proven a valuable aid in deciding as to the depth and inclination to be given to a channel that would be practically free from the evil effects due to the cause mentioned.

At an average stage of water in the lake, the present section of canal delivers, at Lockport, according to our measurements, 17,600 cubic feet of water per minute. Under the present arrangement, part of this quantity is used to drive machinery; a part is wasted into the river below; the remainder being used to supply the locks and short reaches of canal between this point and Joliet.

I have calculated the probable quantity of water necessary to supply the river and canal after improvement, and find that 2,064 cubic feet per second will be required. This amount includes losses from evaporation and filtration, and a quantity equivalent to one lockage every ten minutes.

To meet these demands and the wants of the proposed navigation, it will be necessary to construct a channel 160 feet wide at the water-line and 8 feet deep, with slopes of 1½ to 1. These dimensions give a water area equal to 1,168 square feet, the slope or fall to be 0.28 feet per mile.

The proportions of this section would be varied somewhat where the rock excavation occurs, the width being reduced to 150 feet and the side slopes ¼ to 1, while the depth and inclination would remain constant. The mean velocity of the water in this channel would be 106.2 feet per minute, or 1.21 miles per hour, with a discharge of 124,042 cubic feet per minute.

It will be noticed that the areas of the proposed channel and the present channel are as 2.6 to 1, while the respective capacities per minute are as 7 to 1.

Inspection of the profile shows the proposed grade of the canal at Lockport to be some 6 feet below the grade of the present canal at the same point. I have proposed to raise the level between locks Nos. 1 and 2, continuing the summit-level to lock No. 2; also, to raise the level between 2 and 3, dispensing with the construction of one lock and reducing the total number of lift-locks on the division to three, with an average lift of 11.57 feet.

The estimate contemplates a guard-lock and waste-weir on the summit. It is proposed to construct the former at the head of the canal at Chicago, and to locate the latter near lock No. 1, below Lockport. It also provides for revetting the side slopes of the canal where it is not in rock excavation. A towing-bank has not been included in the estimate, as it is presumed that the most approved methods of propelling vessels will be adopted on this route. One double-track railroad draw-bridge and two wagon-road draw-bridges are the principal accessory works on this division. The estimate covers others of minor importance. This division will cost $11,532,932.40, or an average per mile of $353,229.17.

Second Division.—This division will consist of slack-water navigation, except a short line of independent canal around the rapids in the river at Marseilles.

From a point a short distance above the city of Joliet the Des Plaines River flows in a southwest direction for a distance of sixteen miles; here it unites with the Kankakee coming in from the southeast, and forms the Illinois. The latter follows a course almost directly west to beyond La Salle.

On the first five miles of this division the river has cut through the bottom of the drift, forming its bed in the limestone beneath. At the end of the fifth mile, counting from the east line of this division, the rock makes a dip and does not appear again until the fiftieth mile is reached.

Throughout the remainder of the distance, except one or two short intervals, the stream flows over a rocky bed.

The Des Plaines and Illinois Valley is from a mile to a mile and one-half wide, and varies greatly in its character in different portions of the country, which is due to the different geological formations that outcrop along its course.

On the upper portion of the stream, below Joliet, the rock underlying the valley is

covered with a stratum of yellow marly clay; farther down this is again overlaid with a thin layer of black mold, deposited during the periods of high water. Just above and below the town of Morris, the valley increases in width, and there is a greater depth of soil. At these points the valley, being very fertile, is advantageously cultivated. Passing beyond this westward, near the eastern boundary of La Salle County, we find the Saint Peter's sandstone formation; considerable areas of rock being laid bare in the valley, renders it unfit for cultivation.

Near Utica the calciferous formation underlying the Saint Peter's comes to the surface. Some distance yet beyond this occurs one of those peculiar dips in the stone formation known as an anticlinal axis. Here, as noticed by Professor Freeman, is a remarkable change; the harder character of the calciferous rocks has resisted the eroding action of the water in the valley better than the softer material of the coal-measures, and the surface of the valley is mostly above the level of the freshets of the river. But as soon as the coal-measures are reached, beyond Utica, the whole valley is denuded, so that it is annually overflowed by the rise of the river.

Throughout the entire course of the stream as examined, it was noticed that there have been but few changes in the course of the bed through the valley.

There is evidence of a change having taken place at La Salle. Opposite that city there exists a bayou, extending from the river, near the entrance of the canal, parallel with the general course of the valley up to a point near the Illinois Central Railroad bridge. This bayou presents the appearance of having been the main channel of the river in the past. The location relative to the present channel will be shown on the maps.

The principal affluents of the Illinois which enter from the north are the Du Page, Au Sable, Fox, and Little Vermillion Rivers, while from the south come the Kankakee, Mazou, Waupecan, and Great Vermillion Rivers. As these streams have, like the large one, worn their way down through the drift, they have undoubtedly attained a constant regimen.

It is thought that the amount of matter discharged by these during times of flood cannot have a very considerable effect on the condition of the Illinois River after improvement.

Soundings were taken throughout the entire length of river examined, and cross-sections of the valley were run at intervals, and near the site of any proposed work or improvement the general contour of the valley was closely noted. The river is tolerably uniform in width, averaging a little more than 600 feet between banks. These latter are from 10 to 25 feet above the surface of low water.

Although the width of the channel is, in a measure, constant, the depth of the section and the inclination of the surface of water varies greatly at different points. The maximum fall occurs at the Marseilles Rapids, being 9.36 feet per mile. The minimum is found through what is known as Joliet Lake, where the surface has an inclination of $\frac{2}{1000}$ feet per mile.

Owing to the great rise in the surface of water during freshets, it will be necessary to place draw-spans in the bridges crossing the river. This estimate covers the cost of such draws where not already provided.

Throughout the survey the river continued at its lowest stages. It was carefully gauged at different points while in this condition. At a section nine miles below Joliet the discharge was 523 cubic feet per second. At La Salle the discharge was 933 cubic feet per second. The total fall in the plane of low water was found to be 103 feet. The velocity varies greatly, being that due to the fall, with the necessary modifications, at different points.

It is proposed to overcome the natural descent of 103 feet by means of eleven locks and dams; the dams to be constructed of wooden cribs, filled with stone, to have stone abutments; the locks to be of cut stone, and of the same dimensions as those on the first division; the whole to be built in the most substantial manner. Eight of these locks and dams will be founded on rock. At the sites chosen for the remaining three I found it impossible to ascertain accurately the outline of the rock. I have, therefore, estimated for bearing-piles and concrete at each of these.

Two of the dams necessary already exist; one at Joliet and one at Marseilles. These will be slightly increased in height.

The following is the location and height of the several dams, together with the position and lift of the accompanying lock, reckoning the distance of each from the east line of the division, or where the canal joins the river.

Commencing with the dam in the river at Joliet, belonging to the State, and known as Dam No. 1, we find it is .65 mile beyond the junction of the canal. This dam will be raised four-tenths of a foot. Lock No. 4, of 13 feet lift, will be located here. One mile from this is the second dam, owned by the State. It is proposed to remove this, and also the stone arches that span the river at this point, and replace them with an iron draw.

Passing beyond, 2,000 feet, we find Dam No. 2. This dam was originally built for milling purposes, and is not in good condition. It is thought advisable to remove this

dam, replacing it by another 12½ feet in height. Lock No. 5, of 10½ feet lift, will be located at this point.

The site of Dam No. 3 and Lock No. 6 is chosen on the first half of the fifth mile. This lock has a lift of 9½ feet, the dam rendering the channel navigable for 2.7 miles.

On the eleventh mile occurs Dam No. 4 and Lock No. 7, of 10 feet lift. This dam raises the surface of water 8½ feet, the pool being 5.7 miles in length. On the eighteenth mile Dam No. 5 creates a pool seven and a half miles long. At this dam Lock No. 8 connects with a pool 12.4 miles in length, formed by Dam No. 6, located on the thirtieth mile. Here we have Lock No. 9, of 8 feet lift, falling into the pool of the Marseilles Dam. This dam, situated at the end of the forty-third mile, is to be raised 2.3 feet, giving a navigation of 13.1 miles. Here Lock No. 10, of 14 feet lift, with a reach of independent canal 2.8 miles in length, forms the navigation around the Marseilles Rapids. The first dam below the rapids is known as No. 8. This dam produces a suitable depth of water for 3.7 miles from the preceding lock to Lock No. 11, of 10 feet lift, which opens into a pool 6.4 miles in length, formed by Dam No. 9, located on the fifty-fourth mile. Lock No. 12, of 6 feet lift, corresponds to Dam No. 9.

At the end of the sixtieth mile Dam No. 10 creates a pool of 6.9 miles in length. Lock No. 13, of 9 feet lift, opens into a pool five miles in length above Dam No. 11. This dam raises the surface of water 4.6 feet, and is the last of the series required to make the navigation complete. The location for this was chosen on the sixty-fifth mile. Here Lock No. 14, of 5 feet lift, joins the contemplated navigation with the existing slack-water improvement below.

A more extended examination might result in a change in the final location of the dams; yet such changes cannot affect the estimate to any considerable extent.

Before the improvement of this division is commenced, a series of observations should be inaugurated, with a view of obtaining a more thorough knowledge of the river under its varying stages than could be obtained during the short period allotted to this survey. Again, it would be of interest to compare carefully the real with the calculated effects produced on this portion of the river by the improvement of the division above. Such a course might lead to an important modification of the plans proposed.

As shown by the survey, the damages resulting from overflow of lands adjacent to the river amount to so little that they can be omitted here.

This division will cost $4,347,879.80, or an average of $65,254.07 per mile.

Third Division.—November 14 I received an order to resurvey a part of the western division of the Hennepin Canal route, and to examine the country lying between the Rock and the Mississippi Rivers; the survey to be conducted especially with a view to ascertain the most favorable point on the river at which to establish the western terminus of this route.

With a small party I repaired to the field, but the inclement weather interfered very seriously with the work. The bad state of the weather continuing, and the close of the season being at hand, it was determined to postpone this part of the work until the opening of another season.

During a hurried examination of the country I found another reason for deferring the work in the fact that this survey should, to accomplish the best result and to furnish the information desired, embrace a resurvey of the entire western division of this route.

The notes collected are too meager to base an estimate upon, and I refrain from expressing an opinion as to the probable relative advantages of certain proposed terminal points.

The prices of the various kinds of work here included were fixed after consulting the most reliable local sources.

The surveys that have already been made of the principal part of this route render it possible to begin the location and actual construction of the work at as early a day as may be convenient to the authorities in charge.

This division will cost (according to a former estimate for a commercial canal) $3,899,722.64.

In closing this report, I desire to tender thanks to the State canal authorities for their cordial co-operation and for the many courtesies extended to us.

The commercial importance of this great route has been so thoroughly discussed and so universally conceded, that I deem it unnecessary to refer to that view of the subject in this connection.

The maps, plans, and profiles to accompany this report are preparing, and will be submitted as soon as completed.

Appended to this report, as before mentioned, is a statement in detail of the cost of the first and second divisions of the work.

The following summary shows the number of miles, the amount of lockage, and the total cost of the entire work complete, extending from Lake Michigan to the Mississippi:

SUMMARY.

	Length.	Lockage.	Average cost per mile.	Total cost.
	Miles.	*Feet.*		
First division	32.65	34.7	$353,229 17	$11,532,932 40
Second division	66.63	103.0	65,254 07	4,347,879 80
First and second divisions combined	99.28	137.7	159,959 83	15,880,812 20
Third division	65.31	299.0	59,710 90*	3,899,728 64
The whole route complete from Lake Michigan to the Mississippi River, embracing the first, second, and third divisions	164.59	436.7	120,180 66	19,780,534 84

* Including the cost of the feeder.

Very respectfully, your obedient servant,

F. C. DORAN,
Civil Engineer, Assistant.

Col. J. N. MACOMB,
Corps of Engineers, U. S. A.

Es m te to accompany the report of the survey of the Illinois and Michigan Canal and a part of the Illinois River, made during the autumn of 1874, *by Frank C Doran, civil engineer, under the direction of Col. J. N. Macomb, U. S. A., showing the estimated cost, in mile sections, of a ship-canal from Chicago to Joliet, a distance of* 32.65 *miles, and the cost in sections of the improvement of the Illinois River from Joliet to La Salle, a distance of* 66.63 *miles.*

FIRST DIVISION.

Mile sections	Cubic yards of excavation.	Price.	Amount.	Cubic yards of rock excavation.	Price.	Amount.	Locks.	Cost.	Road bridges.	Cost.	Railroad bridges.	Cost.	Miles of walling.	Cost.	Miscellaneous.	Cost.	Cost per mile.
1	435, 895	$0 30	$136, 768 00	....	....	....	...	....	...	....	...	....	2	$5, 476 00	1 guard-lock and basin	$175, 000 00	$317, 244 00
2	410, 880	30	123, 261 00	....	....	....	...	....	1	$12, 000 00	1	$15, 000 00	2	5, 476 00	....	....	155, 740 00
3	472, 290	30	141, 687 00	....	....	....	...	....	...	....	...	....	2	5, 476 00	....	....	147, 163 00
4	540, 736	30	162, 221 00	....	....	....	...	....	...	....	...	....	2	5, 476 00	....	....	167, 697 00
5	555, 650	30	166, 695 00	....	....	....	...	....	...	....	...	....	2	5, 476 00	....	....	172, 171 00
6	521, 303	30	156, 391 00	....	....	....	...	....	...	....	...	....	2	5, 476 00	....	....	161, 867 00
7	510, 312	30	153, 094 00	....	....	....	...	....	...	....	...	....	2	5, 476 00	....	....	158, 570 00
8	521, 921	30	156, 576 00	....	....	....	...	....	...	....	...	....	2	5, 476 00	....	....	162, 052 00
9	554, 025	30	166, 207 00	....	....	....	...	....	1	9, 000 00	...	....	2	5, 476 00	....	....	180, 683 00
10	533, 300	30	159, 990 00	....	....	....	...	....	...	....	...	....	2	5, 476 00	....	....	165, 466 00
11	579, 416	30	173, 914 00	....	....	....	...	....	...	....	...	....	2	5, 476 00	....	....	179, 391 00
12	520, 892	30	156, 268 00	....	....	....	...	....	...	....	...	....	2	5, 476 00	....	....	161, 744 00
13	504, 210	30	151, 263 00	....	....	....	...	....	...	....	...	....	2	5, 476 00	....	....	156, 739 00
14	528, 588	30	158, 576 00	....	....	....	...	....	...	....	...	....	2	5, 476 00	....	....	164, 052 00
15	377, 296	30	113, 189 00	122, 543	$1 60	$196, 059 00	...	....	...	....	...	....	...	....	....	....	314, 734 00
16	307, 012	30	92, 104 00	207, 784	1 60	332, 455 00	...	....	...	....	...	....	...	....	....	....	424, 559 00
17	316, 973	30	95, 092 00	210, 963	1 60	337, 541 60	...	....	...	....	...	....	...	....	....	....	432, 633 00
18	382, 530	30	114, 759 00	169, 180	1 60	270, 687 00	...	....	...	....	...	....	...	....	....	....	385, 446 00
19	332, 161	30	100, 548 00	128, 083	1 60	204, 933 00	...	....	...	....	...	....	...	....	....	....	305, 481 00
20	197, 341	30	59, 202 00	337, 656	1 60	540, 250 00	...	....	...	....	...	....	...	....	....	....	599, 452 00
21	150, 875	30	45, 262 00	378, 053	1 60	604, 885 00	...	....	1	9, 0 0 00	...	....	...	....	....	....	659, 147 00
22	133, 409	30	40, 023 00	400, 832	1 60	641, 331 00	...	....	1	1, 000 00	...	....	...	....	....	....	691, 354 00
23	107, 496	30	32, 249 00	371, 395	1 60	594, 232 00	...	....	...	....	...	....	...	....	....	....	626, 481 00
24	110, 696	30	33, 209 00	360, 496	1 60	576, 794 00	...	....	...	....	...	....	...	....	....	....	610, 003 00
25	126, 794	30	38, 038 00	364, 523	1 60	583, 238 00	...	....	...	....	...	....	...	....	....	....	621, 276 00
26	106, 428	30	31, 928 00	382, 185	1 60	611, 496 00	...	....	1	9, 000 00	...	....	...	....	....	....	652, 424 00
27	110, 843	30	33, 253 00	368, 959	1 60	590, 334 00	...	....	...	....	...	....	...	....	....	....	623, 587 00
28	216, 186	30	64, 856 00	112, 898	1 60	180, 637 00	...	....	...	....	...	....	...	....	....	....	245, 493 00
29	255, 778	30	76, 733 00	....	....	....	...	....	...	....	...	....	2	5, 476 00	....	....	82, 209 00
30	157, 005	30	47, 101 00	....	....	....	...	....	1	10, 500 00	...	....	2	5, 476 00	....	....	63, 077 00
31	113, 325	30	33, 997 00	....	....	....	1	$184, 385 00	...	....	...	....	2	5, 476 00	....	....	22, 385 00
32	68, 855	30	20, 656 00	....	....	....	2	368, 770 00	...	....	...	....	2	5, 476 00	1 waste weir	30, 000 00	424, 902 00
33	141, 043	30	42, 313 00	....	....	....	...	....	...	....	...	....	2	5, 476 00	....	....	47, 789 00
																	10, 484, 484 00
Add 10 per cent. for contingencies																	1, 048, 448 40
Total																	[illegible]

SECOND DIVISION.

Estimate of the cost of eleven dams and eleven locks between Joliet and La Salle, to give 7-feet navigation, the lock being of sufficient dimensions to pass the largest class of river-steamboats, viz, 350 feet between the gates and 75 feet in width.

SECTION ONE.

Lock No. 4 and Dam No. 1:

Cost of lock	$187,424
Raising dam	5,184
Total	192,608

SECTION TWO.

Lock No. 5 and Dam No. 2:

Cost of lock	$189,884
250 linear feet of dam	40,284
Two draws in road-bridges	20,000
Removal of old lock and dam	2,000
Removal of stone bridge and replacing with draw	12,000
Draw in railroad-bridge	12,000
Removal of Cat Island	2,490
Total	278,658

SECTION THREE.

Lock No. 6 and Dam No. 3:

Cost of lock	$207,939
1,090 linear feet of dam	149,841
Dredging at Joliet Bar	97,646
Total	455,426

SECTION FOUR.

Lock No. 7 and Dam No. 4:

Cost of lock	$199,983
445 linear feet of dam	59,446
Dredging at bars Nos. 2 and 3	9,875
Draw in road-bridge	9,000
Removal of Kankakee feeder aqueduct	1,000
Total	279,304

SECTION FIVE.

Lock No. 8 and Dam No. 5:

Cost of lock	$201,333
950 linear feet of dam	152,098
250 feet of dike across slough	1,250
Draw in road-bridge at Morris	9,000
Total	363,681

SECTION SIX.

Lock No. 9 and Dam No. 6:

Cost of lock	$204,317
540 linear feet of dam	91,924
Total	296,241

SECTION SEVEN.

Lock No. 10 and Dam No. 7:

Cost of lock	$184,385
Raising dam	13,950
Excavation of independent canal around rapids at Marseilles	613,782
Draw in road-bridge at Seneca	9,000
Dredging at bars Nos. 4 and 5	959
Total	822,076

SECTION EIGHT.

Lock No. 11 and Dam No. 8:

Cost of lock	$206,714
500 linear feet of dam	75,281
Total	281,995

SECTION NINE.

Lock No. 12 and Dam No. 9:

Cost of lock	$208,285
900 linear feet of dam	104,631
Draw in road-bridge at Ottawa	9,000
Draw in railroad-bridge at Ottawa	15,000
Total	336,916

SECTION TEN.

Lock No. 13 and Dam No. 10:

Cost of lock	$205,959
860 linear feet of dam	129,984
Total	335,943

SECTION ELEVEN.

Lock No. 14 and Dam No. 11:

Cost of lock	$210,830
575 linear feet of dam	98,940
Total	309,770

Recapitulation of the cost of eleven dams and eleven locks for the Illinois River, between Joliet and La Salle, designed to give 7-feet navigation, the locks to be 350 feet between miter-sills, and 75 feet wide in the chamber.

Numbers of locks and dams.		Lift.	Length of dam.	Length of pools.	Cost of construction.
Lock.	Dam.	Feet.	Feet.	Miles.	Amount.
4	1	13.17	300	0.65	$192,608 00
5	2	9.00	250	1.01	278,658 30
6	3	11.00	1,090	2.69	455,426 00
7	4	10.00	440	5.69	279,304 00
8	5	8.00	950	7.46	363,681 00
9	6	8.00	540	12.38	296,241 00
10	7	14.00	930	13.08	822,076 00
11	8	10.00	500	3.67	281,995 00
12	9	6.00	900	6.44	336,916 00
13	10	9.00	860	6.86	335,943 00
14	11	5.00	575	4.96	309,770 00
Total					3,952,618 00

Total cost of construction	$3,952,618 00
Add 10 per cent. for contingencies	395,261 80
Total	4,347,879 80

CC 8.

THIRD SUBDIVISION OF THE NORTHERN TRANSPORTATION-ROUTE.

REPORT OF MAJOR J. M. WILSON, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Oswego, N. Y., December 24, 1874.

GENERAL: The act of Congress approved June 23, 1874, directed that certain surveys and estimates should be made of the various routes of

transportation recommended by the select committee of the United States Senate in their report of April 24, 1874.

On the 2d of July I was notified by the Chief of Engineers that he had assigned to me, in addition to my other duties, the subject comprised in the third subdivision of the northern route, viz, the examination and formation of estimates of the probable cost of the enlargement and improvement, with the concurrence of the State of New York, of one or more of the three water-routes from the lakes to New York City.

These include the Erie Canal from Buffalo to Albany, the Oneida Lake Ship-canal from Oswego to Albany, and the Champlain Ship-canal from Lake Champlain to deep water on the Hudson River, including such connections as may be effected between Lake Champlain and the Saint Lawrence River, with the co-operation of the British provinces.

In September I was instructed by the Chief of Engineers that, upon the Champlain route, Troy would be the southern limit of my field, as far as the Hudson River was concerned, and, at a later date, I was further directed to include in the consideration of that route the alternative of leaving the river above the Troy dam, and continuing the route by ship-canal to Albany.

OBJECT OF THE SURVEYS.

The object of these surveys and estimates was to secure the greatest amount of exact information in reference to the cost of enlarging these great water-routes between the lakes and tide-water, so that they should comply with the requirements of the present age, and afford ample facilities to the rapidly-increasing demands of the Great West for the transportation of her products to the markets of the East.

CHARACTER OF THE WORK.

The national character of this great work, the benefits to be derived from each route, and the combined benefits of the proposed system of improvements, have been so ably and thoroughly discussed by the United States Senate committee, and their views supported by such a mass of statistics, that I am satisfied that it is neither expected nor desired that I should enter into a discussion of its necessity, and I shall therefore confine myself entirely to a description of the routes and the engineering operations required, and present necessary estimates of the cost of carrying out the end in view.

Immediately after the receipt of my instructions, I entered upon the duties assigned to me, and proceeded to gather all possible data upon the subject. The limited funds at my command, $6,000, rendered it necessary that I should avail myself of all the information I could obtain from surveys already made, and through the great courtesy and kindness of the chief engineer of the State of New York and his assistants, who promptly placed the records of their offices at my service, I have only found it necessary to make new surveys over portions of the routes, but have caused complete and careful reconnaissances to be made over all three lines, and have personally examined the most important localities.

DIVISION OF THE WORK.

The subject naturally divided itself into three parts, and to each division I assigned capable and efficient civil engineers with proper assistants.

The reports of these gentlemen, transmitted herewith, are the result of careful study and close examination, and their reputations in their profession are such that the utmost reliance can be placed upon their conclusions.

It will be perceived that free use has been made of the reports of previous surveys of these various routes, but every item has been closely and carefully studied before being offered as correct, and the reports are replete with data never before presented.

THE ERIE-CANAL ROUTE.

History and description of the present canal.—This great water route, passing through the garden-district of the Empire State, connects Lake Erie at Buffalo with the Hudson River at Troy and Albany.

In 1808 the surveyor-general of New York was directed to survey a route for a canal from the Hudson River to Lake Erie. Three years later a commission reported that a continuous canal on "an inclined plane' was practicable, and in 1811 the legislature directed the construction of the present route. The war of 1812 prevented the continuation of the work, and nothing further was done until 1816, when a new commission was formed.

The work was commenced July 4, 1817, and completed in 1826. The prism of the canal was 40 feet at surface, 28 at bottom, with a depth of 4 feet, and it was navigable at that time for boats of seventy-six tons burden.

In 1834 the legislature of New York directed that double-locks should be constructed on a part of the line, and in 1835 its enlargement was authorized, so as to be navigable for boats of two hundred and forty tons.

It is now three hundred and fifty-one and seventy-eight hundredths miles long, with seventy-one lift and two guard locks, and a lockage of $654\frac{8}{10}$ feet; the lift-locks are all double except at one or two localities, and at those places it is anticipated that the work of doubling will soon be completed. These locks are 110 feet long, 18 feet wide, with a depth of 7 feet on the miter-still; the maximum lift is $15\frac{1}{2}$ feet, which occurs at Albany.

The prism of the canal is 70 feet at surface, 56 feet at bottom, with a depth of 7 feet from Albany to Rochester; at Rochester, it is 71 feet wide at the surface, and 53 feet at the bottom, with a depth of $7\frac{1}{4}$ feet; it increases regularly from Rochester to Lockport, at the latter place being 98 feet on the surface and 79 at the bottom, with a depth of $7\frac{1}{2}$ feet; the grade of the bottom between these last-mentioned places is forty-three thousandths of a foot to the mile.

From Lockport, for three miles, the canal passes through a heavy rock-cutting; the prism is 62 feet on the surface and 60 feet at the bottom, with a depth of 9 feet; to Tonawanda, twelve miles, using Tonawanda Creek, it is 200 feet wide on the surface and 9 feet deep; to Black Rock, eight miles, it is 80 feet wide on the surface, 60 feet on the bottom, and from 8 to 9 feet deep.

The boats now navigating the canal are 98 feet long, $17\frac{5}{12}$ feet wide, and draw $6\frac{5}{12}$ feet; the maximum burden is two hundred and forty tons; the trunk of the canal is capable of doing three times the business done with the present class of boats.

Enlargement of locks.—In 1863 surveys and estimates were made under the direction of the State engineer of New York for constructing a series of enlarged locks alongside the present ones, so as to pass gunboats

from tide-water to Lake Erie. This was done carefully, elaborately, and faithfully, and a full and detailed report submitted.

To that report I am indebted for the most valuable information, and I have fully relied upon the data it contains, knowing the high character and ability of the engineers engaged upon the work.

Object of the present examination.—The object of the present examination and estimate is to determine the cost of enlarging one tier of the present locks, so as to pass boats 210 feet long and 25 feet wide, with a draught of $6\frac{5}{12}$ feet, the burden being six hundred and ninety tons, and to deepen the canal to 8 feet, except upon mechanical structures.

The enlarged locks are to be 225 feet long, 26 feet wide, and the depth upon the miter-sill will be 7 feet.

Mr. Octave Blanc, assistant engineer, whose report is transmitted herewith, has most carefully studied the whole subject, and presents estimates for enlarging one tier of the present locks, &c. This plan is recommended by him, except in certain localities, and in this recommendation he is sustained by the most competent canal-engineers.

I have thoroughly examined the case and personally inspected the most prominent localities along the whole line, and agree with him perfectly. Although estimates have heretofore been made both for a new tier of locks and for enlarging the present ones, I earnestly recommend, should the work be undertaken, that the latter plan be adopted. In enlarging one lock navigation will be only partially impeded, and if appropriations are made so that materials can be purchased in the summer and delivered at the proper localities, the work can be rapidly advanced during the winter; moreover, boats of the size now navigating the canals will, in case the locks are enlarged, cease to be used in a few years, and then, if the demands of commerce render it necessary, the other locks can be readily improved.

In accordance with my instructions, these estimates have been prepared for stone locks only, using the best class of materials. In a work of this magnitude only the most durable materials should be used.

Deepening the canal.—In the advancement of science, it is certain that steam-power upon the canals will erelong be used entirely, and, therefore, every facility should be offered for the rapid movement of boats. During the past season great progress has been made in the use of steam, and the fact has been clearly shown that, with extended facilities for its use, cheap transportation over this canal can be secured. The present boats, drawn by horses, consume from ten to twelve days in going from Buffalo to Albany, while the steam canal-boats used the past season have made the trip in six. For this reason I have thought best to estimate, also, for deepening the canal, so that there will be nowhere, except upon mechanical structures, a less depth than 8 feet. This will give sufficient water to allow steamboats drawing $6\frac{1}{2}$ feet to navigate the canal without difficulty.

Water-supply.—Mr. Martin King, assistant engineer, has given the subject of the water-supply the most careful attention, and the statement prepared by him, and submitted in Mr. Blanc's report, gives sufficient data to show that a full supply can be maintained without difficulty.

In the last report of the canal commissioners of the State of New York the following statement occurs:

The whole number of boats cleared at Buffalo during the season of 1873 shows a daily average of nearly fifty, which may be classified as follows:

Grain-boats, daily	30
Lumber-boats, daily	10

Staves, shingles, and hoops boats, daily	5
Miscellaneous cargo boats	5
Total	50

Fifty boats clearing and fifty arriving, making one hundred lockages per day, or nineteen thousand lockages in the aggregate during the past season, which is eleven thousand less than can be made with single locks alone.

The new boats to be used will have a capacity of more than three times those now in use, and for this reason I have concluded that a water-supply sufficient for the passage of one hundred of these will accommodate the demands of commerce for many years to come, and have based my estimates accordingly.

The main supply of the canal between Buffalo and Clyde is derived from Lake Erie, and the source is ample for the purpose, if properly managed.

The Montezuma level, the lowest on the canal, drains from both sides, and has never given trouble.

The Port Byron and Jordan levels, which have given rise to questions as to the sufficiency of their supply, are shown to have a surplus of over 8,000,000 cubic feet per twenty-four hours, a fact certainly to be a source of gratification, as all natural feeders have already been brought into use.

Upon the Rome or long level there is at present a large surplus, and the Fish Creek feeder, for which estimates, based upon quantities as given in the report of the New York State engineer for 1864, have been made, can supply in addition over 10,000,000 cubic feet per twenty-four hours throughout the season. As the present Oneida Lake Canal is also to be supplied from this level, but has not been considered in Mr. Blanc's report, allowance must be made for it; it will require about 5,000,000 cubic feet per twenty-four hours, leaving still a large available surplus for the long level.

From this level to Albany the supply is abundant and far in excess of the demand. I am therefore satisfied that a full and sufficient supply of water can be obtained to answer all the demands of commerce for many years to come upon the Erie Canal with its locks enlarged.

Present project.—It is now proposed to enlarge one tier of the present locks throughout the whole line of the canal, except at Albany, West Troy, Lockville, and Lockport.

At Lockville, the new canal, three-quarters of a mile long, as projected by State Engineer Story, of New York, is recommended, with two locks of 12-feet lift each, thus cutting off the bend in the present canal, and overcoming the fall with two instead of three locks, as at present.

At Lockport it is also deemed best to construct a new flight of locks, as recommended by the same engineer, alongside the present ones, and overcoming the fall with three instead of five locks as at present. This is so arranged that, should it be demanded in the future, another tier can be constructed. A new race is also projected, with drop over breast-walls instead of the inclined plane now used.

Cost of the project.—The cost of the proposed work, which includes the enlargement of locks, changes in aqueducts, bridges, culverts, &c., incident thereto, and deepening the canal, so that there will be nowhere, except upon mechanical structures, a less depth than 8 feet, will be as follows:

Locks	$4,421,711 80
Aqueducts, culverts, bridges, &c	363,777 25
Removing bench-walls	710,000 00
Widening canal near aqueducts	9,925 00

Deepening canal	$1,361,241 00
Land damages	190,000 00
Engineering and contingencies, 10 per cent	686,665 50
Fish Creek feeder	430,276 00
Total	8,173,596 55

Or, without deepening the canal, $6,676,231.45.

Time of completion.—In the opinion of the most competent engineers this work could be completed in two years if proper appropriations should be made. The summer could be used for transportating the necessary materials to the upper localities, and the work would be done during the winter with but a partial interference with navigation for two seasons only.

THE ONEIDA LAKE SHIP-CANAL ROUTE.

History and description of the route.—This route includes the Welland Canal, which connects Lake Erie with Lake Ontario, Lake Ontario from Port Dalhousie to Oswego, the Oswego Canal enlarged, to the mouth of Brandy Brook near Phœnix, N. Y., a new canal and Oneida River to Oneida Lake, the Lake and Oneida Canal to Durhamville, and the enlarged Erie Canal to Albany, thus making a through water-route connecting Lake Erie with tide-water on the Hudson.

The early history of inland navigation between Albany and the lakes shows that the regular line of communication was by way of the Mohawk River, Wood Creek, Oneida Lake, and the Oneida and Oswego Rivers, the only break being near Rome.

The project of improving the Mohawk and cutting a channel across the portage near Rome, attracted attention at a very early date, and reference was made to the subject by the surveyor-general of New York in 1724, and the governor in 1768.

In 1791 the legislature directed surveys and estimates to be made for building a canal across this portage, and in 1808 the surveyor-general of New York reported that a canal could be constructed from Oneida Lake to Lake Ontario.

In 1825 the construction of the Oswego Canal was commenced, and in 1828 it was completed to its junction with the Erie Canal; in 1847 its enlargement was authorized, and this was finished in 1862; in 1832 a canal connecting Oneida Lake with the Erie Canal at Higginsville was authorized, and it was completed in 1836; in 1839 the improvement of the Oneida River was undertaken, and upon its completion, in 1850, there was a direct water-line upon this route from the tide-wider to Lake Ontario for boats of seventy-six tons burden, drawing 3½ feet water.

In 1867 a new line was located for the Oneida Lake Canal, intersecting the Erie Canal at Durhamville, and its construction, together with the improvement of the Oneida River, was ordered so that boats of two hundred and forty tons burden could pass from the Hudson at Albany, to Lake Ontario at Oswego; the work upon this improvement is now in progress.

The present route.—At present the route, including the incomplete portion, consists of the Oswego Canal to Oneida River, thence by that river to Oneida Lake, thence through the lake and Oneida Canal to Durhamville, thence by the Erie Canal to Albany. The total length of this route is two hundred and seven and nine hundred and thirty-five thousandths ($207\frac{935}{1000}$) miles as follows:

	Miles.
From Oswego to Phœnix	20.5
From Phœnix to Oneida Lake, via Oneida River	21.634
Through Oneida Lake to canal	21.339
Oneida Lake Canal to Durhamville	5.081
Durhamville to Albany	139.380
Total	207.935

There are thirteen lift-locks between Oswego and Phœnix, with a lockage of 112.67 feet; upon the Oneida River there are two lift-locks, with a lockage of 7.13; upon the Oneida Canal, six lift-locks, with a lockage of 62 feet; and upon the Erie Canal, forty-six lift-locks, with a lockage of 426.96 feet; making a total of sixty-seven locks, with a lockage of 608.76 feet, of which 181.08 feet ascends, and 426.96 feet descends eastwardly.

The new project.—It is now proposed to enlarge this route, which nature has provided and art improved, by constructing a ship-canal from Oswego to Albany.

THE WELLAND CANAL.

The new Welland Canal, now in process of enlargement, will be twenty-seven and one-fifth miles long, with a lockage of 326 feet; its prism will be 150 wide at surface, 100 feet at bottom, with a depth of 13 feet; the locks, twenty-five in number, will be 270 feet long, 45 feet wide, with a depth of 12 feet on the miter-sill. This will admit the passage of vessels 250 feet long, with a carrying-capacity of 50,000 bushels of wheat. Vessels of this size, passing through the canal and Lake Ontario, will transship their cargoes at Oswego to steam-barges with a carrying-capacity of about 25,000 bushels of wheat, or to barges to be towed with a capacity of 28,000 bushels; and for the passage of these barges through to the Hudson it is proposed to construct the Oneida Lake Ship-Canal.

THE NEW CANAL.

The survey and estimates for this route have been in charge of Mr. James S. Lawrence, a competent and careful engineer, whose report is transmitted herewith, and to which I refer for details.

Mr. Lawrence has given the subject close study for the past four months, and his report is replete with interesting data; his estimates have been made for substantial structures of the most durable character.

THE ROUTES FROM LAKE ONTARIO TO ONEIDA LAKE.

Two routes from Oswego to Oneida Lake are presented for consideration, the one by using the Oneida River throughout its whole length; the other, by what is known as the "cross-cut line," which leaves the Oswego Canal near Phœnix, makes a new canal, two and three-fourths miles long, to Peter Scott's swamp on the Oneida River, thence along that river a short distance, thence again by a canal two and one-eighth miles long to a point on the river near Brewerton, thence by the river to Oneida Lake.

By this latter route, the distance from Oswego to the lake is lessened nearly seven and one-half miles; but the cost is about $962,000 greater; the advantage gained in distance is, however, so great that this route is considered the more preferable of the two, and is recommended as the one to be used.

The route proposed.—The proposed route on this line is therefore as follows:

	Miles.
From Oswego to mouth of Brandy Brook, near Phœnix, N. Y	20.50
From near Phœnix to Oneida Lake, by canal and Oneida River	14.146
Oneida Lake to Oneida Lake Canal	21.339
Enlarged Oneida Canal to Durhamville	5.082
Enlarged Erie Canal, from Durhamville to Albany	139.380
Total	200.447

Total distance, about two hundred and one-half miles.

The prism of the canal and the locks.—The prism of the canal will be 140 feet at the surface, 120 feet at the bottom, with a depth of 10 feet; the locks will be 185 feet between the quoins, 29 feet wide, with a depth of 9 feet on the miter-sill; this will pass boats 170 feet long, 28 feet beam, and drawing 8½ feet, with a carrying capacity of 28,000 bushels of wheat.

There will be sixty-seven lift-locks between Oswego and Albany, with a lockage of 608.76 feet, of which 181.8 will be ascending and 426.96 descending to Albany; there will also be two side-cut locks to enter the Hudson River at Troy.

It is, of course, not contemplated that lake-vessels of large tonnage and expensive equipment will navigate this canal, but that their cargoes will be transferred at Oswego to steam-barges carrying 25,000 bushels of wheat, or to barges of a little greater capacity, which will be towed. This subject is thoroughly discussed in the report of Hon. W. J. McAlpine, who has fully considered the question of the cost of transportation; the whole appears in the report of the United States Senate committee, and it is not deemed necessary to dwell further upon it here.

The water-supply.—Mr. Lawrence has given close attention to the subject of the water-supply upon this route, and presents an array of facts which conclusively proves that all the water can be obtained that the demands of navigation will require.

The large area from which Oneida Lake draws its supply, together with the Oneida, Oswego, and Seneca Rivers, furnishes an abundant supply of water from Oneida Lake to Oswego, and the transfer of a portion of it through Fish Creek feeder to the long level would scarcely be noticed.

The Rome or long level furnishes the supply for the Oneida Lake Canal, and the lockage upon this route near Utica; the present supply upon this portion is shown by Mr. Lawrence to be in excess of the demand, but it is deemed necessary to recommend the construction of Fish Creek feeder, as planned by the New York State engineers, as an additional source of supply in case of accident. This will furnish over 10,000,000 cubic feet daily, and a large portion of the supply thus diverted from Oneida Lake will be returned to it through the Oneida Lake Canal.

Should circumstances ever render it necessary to obtain a still greater supply upon this portion of the route, reservoirs could be constructed for storing the waters of the spring season at the headwaters of the Mohawk, of Fish Creek, of Black River, and among the Chenango Hills.

From Utica to Albany, the principal supply is from the Mohawk; additional amounts being received from minor feeders at various points. The supply upon this portion of the route is shown to be sufficient for the demand.

COST OF THE ONEIDA LAKE SHIP-CANAL.

The estimates made for the construction of this canal show that the approximate cost will be as follows:

From Oswego to mouth of Brandy Brook	$2,652,736 50
From mouth of Brandy Brook to Oneida Lake	1,505,208 00
Oneida Lake, excavation and piers	83,025 00
Oneida Lake Canal to Durhamville	782,899 00
Engineering and contingencies, 10 per cent	502,386 85
Land damages *en route*	397,341 50
Total from Oswego to Durhamville	5,923,596 85

Erie Canal portion of Oneida route.

Durhamville to Albany, including side-cut locks at Troy	$17,012,142 40
Land damages *en route*	1,847,842 00
Fish Creek feeder	430,276 00
Total from Durhamville to Albany	19,290,260 40

From Oswego to Durhamville	5,923,596 85
From Durhamville to Albany	19,290,260 40
Total from Oswego to Albany, N. Y	25,213,857 25

Time of completion.—The time of completion would of course depend upon the amount of the annual appropriations; if funds were promptly supplied, the work could probably be completed in four years.

THE CHAMPLAIN SHIP-CANAL ROUTE.

This route, connecting Lake Erie with the Hudson River, includes the Welland Canal, Lake Ontario, the Saint Lawrence River and canals to Caughnawaga; a new canal from Caughnawaga to Saint John's on the Richelieu River; the Richelieu River to Lake Champlain; Lake Champlain to Whitehall; a new canal in connection with Wood Creek to Fort Edward, and the Hudson River, by means of slack-water navigation, to Troy; from there the route is continued to New York, either by the Hudson River with increased depth, or by leaving the river above the Troy dam, and passing, by means of the Lower Mohawk and the Erie Canal enlarged, to deep water at Albany, N. Y.

THE WELLAND CANAL.

The new Welland Canal, as previously stated, will be twenty-seven and one-fifth miles long, with a lockage of 326 feet, and capable of passing vessels with a carrying capacity of fifty thousand bushels of wheat.

THE SAINT LAWRENCE RIVER AND CANALS.

From Kingston to Caughnawaga, on the Saint Lawrence River, the distance is one hundred and sixty-nine and one-half miles; the canals around the rapids, above Caughnawaga, are five in number, with an aggregate length of thirty-five and one-eighth miles, a lockage of 162 feet, and twenty-two locks; upon the downward trip of steamers these canals are not used. At present, the locks are not capable of passing boats of greater burden than seven hundred tons, but it is stated that the Canadian government proposes to enlarge them so as to pass vessels of the same size as will navigate the Welland Canal, and to improve

the river-channel so as to obtain a depth of not less than 12 feet throughout its entire length.

THE PROPOSED CAUGHNAWAGA CANAL.

The Canadian government has granted a charter to a private company to construct a canal from the Saint Lawrence River, at Caughnawaga, nine miles above Montreal, to Saint John's, on the Richelieu River, in connection with the Chambly Canal, thus connecting the Saint Lawrence with Lake Champlain by a new route. The prism of this canal is to be 150 feet wide at surface, 100 feet at bottom, and the depth 13 feet; the locks are to be 270 feet long by 45 feet wide, with a depth of 12 feet on the miter-sill, so as to pass boats with a carrying capacity of about 50,000 bushels of wheat.

Survey and estimate of cost of Caughnawaga Canal.—This canal will be thirty-two and one-fifth miles long, with three locks and a lockage of 29 feet. The original surveys were made in 1848 by the late J. B. Mills, an engineer of great experience, and the route has been examined several times since by able men in the profession, and pronounced perfectly feasible. A recent approximate estimate of its cost, made by Hon. Walter Shanley, civil engineer, based upon the original estimate of Mr. Mills, places the cost of the construction of the canal at $5,500,000 (gold); the cost of the necessary improvement of the Richelieu River is estimated by Hon. John Young, of Montreal, at $35,000 (gold).

OBJECT OF THE PRESENT EXAMINATION.

The object of the present examination and estimates is to determine the method and cost of constructing a ship canal from Whitehall at the head of Lake Champlain to Fort Edward on the Hudson, and to improve the navigation of the latter river by locks and dams, so that, in connection with the Saint Lawrence River and Canadian canals, steamers with a carrying-capacity of about 50,000 bushels of wheat can pass directly from the lakes to deep water on the Hudson without breaking bulk.

The surveys and estimates for this route have been in charge of Mr. Charles A. Fuller, an able civil engineer, of great experience upon public works. Mr. Fuller has personally examined the whole route from Caughnawaga to Albany, and has given the subject his earnest attention for the past four months. To his report, which is transmitted herewith, I refer for details.

History of this route.—Immediately after the Revolutionary war, the subject of a water-route from the Hudson to Lake Champlain was brought forward, and in 1791 the legislature of New York State directed surveys and estimates to be made for this purpose. In 1792 a company was organized with the intention of completing the water-connection through the valley formed by the Hudson and Lake Champlain, and work was commenced upon a canal from Whitehall to Fort Edward; it was, however, abandoned on account of the great cost of rising from the lake through the rock-formation to Wood Creek. In 1816 the New York State legislature authorized its construction, and in 1822 it was opened for navigation.

The prism of the canal at this time was 40 feet at the surface and 4 feet deep, and the locks 90 feet long and 15 wide. From time to time the depth has been increased, and in 1870 the legislature of New York directed that the prism throughout the canal should be 58 feet at the surface, 44 feet at the bottom, with a uniform depth of 7 feet. This improvement is now in progress.

The proposed route from the Saint Lawrence to Troy.—The distances upon this route are as follows:

	Miles.
From Caughnawaga to Saint John's	32.50
From Saint John's to Rouse's Point	22.00
From Rouse's Point to Whitehall	111.00
From Whitehall to Fort Edward	24.13
From Fort Edward to Troy	39.80
Total from Caughnawaga to Troy	229.43

Of this distance, fifty-four and a half miles are in Canadian territory.

From Rouse's Point to Whitehall, through Lake Champlain, no difficulty will be encountered in obtaining the full depth required, and the labor will therefore be upon the canal and river between Whitehall and Troy, N. Y.

The proposed canal.—The summit-level of the present Champlain Canal is 147 feet above tide-water, and between the lake and Fort Edward there are seven locks, with a lockage of 51 feet.

It was at first thought best to estimate for enlarging this canal to Fort Edward, and there to lock into the Hudson River. A survey for a new line, making use of Wood Creek, however, developed the fact that a canal could be constructed with a summit-level of 135 feet above tide-water, and this has been adopted.

This canal will be 24.13 miles long. The level of Lake Champlain is 96 feet above tide-water, and of the Hudson River, at Fort Edward, 118 feet above tide. The rise of 39 feet from the lake to the summit, a distance of 9.38 miles, will be overcome with three locks, and the fall of 17 feet to the river, a distance of fourteen and three-fourths miles, with one.

Our attention was first called to this new line by Canal Commissioner Barkley, of New York, to whom I am indebted for most valuable information and suggestions, and the survey made through his courtesy showed that it was eminently a desirable one. It has, therefore, been adopted; and it is proposed, in connection with Wood Creek, to construct a new canal from Whitehall to Fort Edward, connecting with the Hudson River at the latter place.

The prism of the canal.—The canal will be 150 feet wide at surface, 100 feet at bottom, and the depth will be 13 feet; the locks will be constructed of the best masonry, and will be 270 feet long, 45 feet wide, with a depth of 12 feet on the miter-sill, and capable of passing vessels with a carrying capacity of about 50,000 bushels of wheat.

Dams.—A dam, 125 feet long, across the mouth of Wood Creek, extending from the Whitehall lock to the east bank of the creek, will be required in order to raise the level to the next lock.

Bridges.—There will be twelve highway, one tow-path, and two railroad bridges required. Those for the highway and railroad will be swing-bridges of 190 feet span.

The river improvement.—From Fort Edward to Troy the distance is 39.8 miles, with a fall of 118 feet.

It is proposed to render the river navigable for this distance by excavating wherever necessary, and by constructing suitable locks and dams. The channel will be 200 feet wide, with a depth of 13 feet.

Locks and dams.—The fall of 118 feet will be overcome by eleven locks and dams, and five auxiliary breast-dams. The locks will be of the same dimensions as upon the canal. The dams will be constructed of masonry laid in cement, with aprons of timber and stone. Of the sixteen dams required, fourteen will be new ones, aggregating 7,037 feet in

length. The dam at Troy, 1,100 feet long, will be raised about 2 feet. The new dam at Saratoga Falls, 846 feet long, will require no change.

Water-supply.—Careful surveys of the region in the vicinity of the headwaters of the Hudson, from which the water for this route will be derived, have recently been made by Prof. F. N. Benedict, and show that an abundant supply can be obtained. At present, the capacity of the Hudson to furnish the required amount is ample, and this could be greatly increased by a proper system of dams and reservoirs at the sources of the river to retain the surplus water until required. A large additional supply can be obtained by directing the flow into the Hudson of certain lakes that now empty into the Saint Lawrence.

Professor Benedict states that at present there can be supplied, over and above the amount now flowing into the headwaters of the Hudson, "60,000,000 cubic feet per diem," or more than the entire amount required for the supply of the enlarged canal.

In this connection, I quote the following from the report of Mr. Verplanck Colvin, made to the legislature of New York in 1873, on the topographical survey of the Adirondack wilderness:

It is to be remarked that if, at any future time, it should become necessary to have a greatly-increased supply of water for the Hudson River or canals, even these distant lakes and rivers can be made tributary. The water of Smith's Lake, and of the lakes and streams emptying into it, could be turned by a dam and canal into Charley Pond, which empties into Little Tupper's Lake. By corresponding treatment, the waters of the latter could be led into Stony Pond, which empties into Long Lake, and then by the dam and canal, long since proposed by Professor Benedict, lead to the headwaters of the Hudson, nearly doubling the upper water-shed of that noble river. In view of the proposed Champlain ship-canal, this source of water-supply may be of interest; but though the expenditure to render it available would be trifling, the consequential damages to mill-owners in the settlements, on the lower waters of the streams thus diverted, would be considerable.

The amount now required for the use of the canal for a period of 220 days, with one hundred lockages daily, is estimated at 57,119,794 cubic feet daily, or 39,666 cubic feet per minute. The report of the State engineer of New York shows the supply at present to be as follows:

Wood Creek can furnish	6,671 cubic feet per minute.
Glen's Falls feeder can furnish	22,715 cubic feet per minute.
Total supply	29,386 cubic feet per minute.

Leaving a deficiency of 10,280 cubic feet per minute. This can be supplied by either enlarging Glen's Falls feeder, or by raising the water of the Hudson to the proper height by a dam above Fort Edward, and using the old Fort Edward feeder, which, since the construction of the Glen's Falls feeder by the State of New York, has been no longer necessary, the latter furnishing all the water required for the present Champlain Canal. The latter plan is recommended, being the cheaper of the two. There is no question but that an abundant supply of water can be obtained upon this route.

Cost of the project.—The following approximate estimate of the cost is submitted:

Canal division.

Dams	$9,939 55
Locks	594,887 84
Prism	1,998,958 66
Regulating-weirs	61,545 78
Bridges	340,764 80
Fort Edward dam and feeder	282,708 00
Property damages	145,831 00
Engineering and contingencies, 10 per cent	343,363 56
Total	3,776,999 19

River division.

Dams	$733,318 32
Locks	1,714,464 88
Channel	4,157,596 00
Levees and property damages	100,000 04
Engineering and contingencies, 10 per cent	670,537 92
Total	7,375,917 16

Summary.

Canal division	3,776,999 19
River division	7,375,917 16
Total from Lake Champlain to Troy	11,152,916 35

Time of completion.—The time required for the completion of this great work would of course depend upon the annual appropriations; if funds were promptly supplied the route could be opened for navigation in three or four years, and operations could be made to keep progress with those upon the Caughnawaga Canal.

CANAL FROM THE HUDSON, ABOVE TROY, TO DEEP WATER AT ALBANY.

The result of operations upon the Hudson River rendered it questionable whether a full depth of 13 feet could be maintained between Troy and Albany; and while the study of that subject was confided to that distinguished and accomplished engineer, General John Newton, I was directed to prepare an estimate for a canal from near Troy to Albany, in order to complete the connections for vessels of a carrying capacity of 50,000 bushels of wheat, between the lakes and deep water upon the Hudson.

This project being a portion of the Champlain route, the plans and estimates for it were assigned to Mr. C. A. Fuller.

It is proposed to leave the Upper Hudson at what is known as the Lower Mohawk entrance, and, using the bed of the old stream, to lock up, with one lock of 10¼ feet lift, into the present Erie Canal, near the West Troy weigh-lock. The channel of the Mohawk will be 200 feet wide and 13 feet deep; this will necessitate considerable rock and earth excavation.

Leaving this channel near the Troy weigh-lock, the present Erie Canal will be widened to 150 feet at surface and 100 feet at bottom, and deepened to 13 feet.

The locks.—There will be three locks; one to rise from the river to the canal at West Troy, one between Troy and Albany, and the third at the exit into Albany Basin; these locks will be 270 feet long, 45 feet wide, with a depth of 12 feet on the miter-sill, and capable of passing vessels of the same size as those with which it is proposed to navigate the Champlain Canal and Upper Hudson.

The water-supply.—The present water-supply is sufficient for the demand upon this portion of the route, if devoted to its legitimate purposes.

The cost of this route.—The cost of this portion of the route, from the lower entrance into the Hudson River of the Mohawk, above the Troy dam, to deep water at Albany, is estimated as follows:

Mohawk River division, two and one-fourth miles	$568,210 64
Erie Canal division, six and six-hundredths miles	1,670,754 58
Property damages	454,650 00
Engineering and contingencies, 10 per cent	269,361 51
Total	2,962,976 73

Time of completion.—The time of completion will depend upon the amount of appropriation, and the operations can be made to keep progress with those upon the other portion of the route.

GENERAL REMARKS.

In presenting this report, I desire to state that I have given careful study to the subject, and have visited the most important localities, going over portions of the route on foot in order to thoroughly acquaint myself with the difficulties with which it would be necessary to contend.

The gentlemen in charge of the various routes have given their whole attention for the past four months to the subjects assigned to them, and present a large amount of interesting information.

For the data upon which we mainly based our calculations I am indebted to the reports of the canal engineers of New York State. These gentlemen, together with the canal commissioner in charge of the eastern division of the State canals, have given me every possible information in their power.

New surveys were made for the line of the proposed Champlain Canal; also of the Lower Mohawk, for the connection with the Erie Canal at West Troy; of the Erie Canal from Albany to West Troy, and in the vicinity of Cohoes, and of portions of Oneida Lake. Cross-sections of the country along the route of the Oneida Ship-Canal were made between Lake Ontario and Oneida Lake, and from Durhamville to Albany. All the locks, aqueducts, culverts, weirs, bridges, &c., upon the existing routes were examined, and careful inspections made to appraise the land damages that would accrue should it be concluded to undertake the improvement upon either route.

The survey for the cross-cut from Phœnix to Oneida Lake was made by the State Engineers C. A. Sweet and M. S. Kimball, to whom I am indebted for valuable information; that of the new route from Whitehall to Fort Edward, by Mr. G. T. Hall, assistant engineer; those of Oneida Lake, the Erie Canal at Cohoes, and between Troy and Albany and the Lower Mohawk between Cohoes and West Troy, by Mr. W. P. Judson, assistant engineer. The latter has also rendered valuable assistance in the preparation of the estimates and charts on all three routes.

For the estimates for improving the Hudson River the map prepared by Mr. S. McElroy, civil engineer, in 1866, was used; full reliance being placed upon the data it contained.

The subject of water-supply has been carefully considered; the data for that now furnished upon the various routes were taken from the reports of the New York State engineers, where the amount available from each feeder is given in detail. The facts presented show that, for the objects in view, on each route the requisite amount of water can be obtained.

In these estimates, evaporation has been taken at one-third of an inch in depth per diem. The allowance for filtration and evaporation has been determined by experiment to be two hundred cubic feet per mile per minute upon the Erie Canal, and has been deduced for the other canals from experiments on the Erie. Leakage through gates is a quantity only to be determined accurately by experiment; with the improved tumble-gates it is said to be 50 per cent. less than with the old style of miter-gates; it is only necessary to take it into account once, as like the lockage, it passes from the higher to the lower levels, and is like a constant flow from one pool to another. It has been assumed here at 30 per cent. of the lockage, which is considered a liberal allowance when gates are properly constructed.

In locks upon the Erie and Oneida Ship-Canals, with 10 feet lift, this will average about 20 cubic feet per second, which is considered a far greater amount than should be permitted upon any well-constructed canal.

I do not feel called upon by the provisions of the law to discuss the relative advantages of these routes, nor to express an opinion as to which is the most preferable.

I have simply presented the facts as they have been found to exist upon each route, with the cost of carrying out the projects determined upon by the United States Senate committee; all three routes are practicable, and each has its advocates and its own peculiar advantages.

The following summary of the canals, as proposed, with approximate estimates of their cost, is submitted:

ERIE CANAL ROUTE.

From Buffalo to Albany.—Length, 351.78 miles; 67 locks, with a lockage of 654.8 feet; prism from Albany to Rochester, 70 feet at surface, 56 feet at bottom; depth, 8 feet; from Rochester to Buffalo, prism increases in width; locks, 225 feet long, 26 feet wide, with a depth of 7 feet on the miter-sill. Navigable for boats capable of carrying 23,000 bushels of wheat.

Approximate cost of entire improvement	$8,173,596 55
Approximate cost without deepening canal	6,676,231 45

ONEIDA LAKE SHIP-CANAL ROUTE.

From Oswego to Albany.—Length 200.447 miles; 67 locks with a lockage of 608.76 feet; prism 140 feet at surface, 120 feet at bottom; depth, 10 feet; locks, 185 feet long, 29 feet wide, with a depth of 9 feet on the miter-sill. Navigable for boats capable of carrying 28,000 bushels of wheat.

Approximate cost of improvement	$25,213,857 25

CHAMPLAIN SHIP-CANAL ROUTE.

From Whitehall to Troy.—Length, canal division, 24.13 miles; river division, 39.8 miles—63.93 miles; 15 locks, with a lockage of 172 feet; canal-prism 150 feet at surface, 100 feet at bottom; depth, 13 feet; river-channel, 200 feet wide and 13 feet deep; locks, 270 feet long, 45 feet wide, with a depth of 12 feet on the miter-sill. Navigable for vessels capable of carrying 50,000 bushels of wheat.

Approximate cost of improvement	$11,152,916 35

SHIP-CANAL FROM THE HUDSON.

From above Troy to Albany.—Length, river division, 2.25 miles; canal division, 6.06 miles—8.31 miles; 3 locks, with a lockage of 35 feet; prism of canal, 150 feet wide at surface, 100 feet at bottom; depth, 13 feet; channel of river, 200 feet wide and 13 feet deep; locks, 270 feet long, 45 feet wide, with a depth of 12 feet on the miter-sill. Navigable for vessels capable of carrying 50,000 bushels of wheat.

Approximate cost of improvement	$2,962,976 74

Respectfully submitted.

JOHN M. WILSON,
Major of Engineers, Brevet Colonel.

Brig. Gen. A. A. HUMPHREYS,
Chief of Engineers U. S. A.

ERIE CANAL ROUTE.

REPORT OF MR. OCTAVE BLANC, ASSISTANT ENGINEER.

OSWEGO, N. Y., *December* 10, 1874.

SIR: In compliance with your instructions of August 20, 1874, I have the honor to present herewith plans and estimates for the enlargement of one tier of the present locks of the Erie Canal, from Albany to Buffalo, except at Lockville and Lockport; also for obtaining a depth of not less than 8 feet throughout its entire length, and to submit the following report:

In May, 1863, the legislature of the State of New York directed that surveys should be made of the line of the Erie Canal between Albany and Buffalo, and plans and estimates prepared for constructing a new tier of locks alongside the present ones, for the purpose of passing gunboats from the Hudson River to Lake Erie; these locks were to be 225 feet long, 26 feet wide, with a depth of 7 feet on the miter-sill.

In compliance with this law, the work was carried out under the supervision of the State engineer of New York, and a report, with elaborate plans and estimates, submitted. To this report I am indebted for the most valuable information.

THE PRESENT PROJECT.

The locks of the Erie Canal at present are 110 feet long, 18 feet wide, with a depth of 7 feet on the miter-sill; for a great portion of its length the depth is not greater than 7 feet; the maximum capacity of boats navigating it is 240 tons.

It is now proposed to construct enlarged locks throughout the whole length of the canal; to make the necessary changes incident thereto in aqueducts, culverts, and bridges; and to deepen the canal so that, except upon mechanical structures, there shall nowhere be a less depth than 8 feet.

The enlarged locks will be 225 feet long, 26 feet wide, with a depth of 7 feet on the miter-sill, and capable of passing boats of 690 tons burden. In accordance with your instructions, I have estimated for enlarging one tier of the present locks, except at Lockville and Lockport, and the connection with the Hudson River at Albany and Troy; the admirable locations selected at those places by the New York State engineers rendering it advisable to adhere to them.

The estimates are based upon the data furnished by the New York State engineers' reports, the localities having been carefully examined, the prices fixed at those now paid for labor and materials, and deductions made for such materials now in the locks as can be again used.

The opinions of all engineers with whom I have conversed coincide in approving the enlargement of one tier of the present locks, instead of constructing an entire new tier.

The New York State engineers, in determining the best principle upon which the enlargement should be based, concluded, after the most deliberate consideration, that the most advisable plan to pursue would be that of lengthening and widening one tier of the present locks. This plan, if properly carried out, could be more easily accomplished than that of an entire new tier, at less expense, with no great hinderance to navigation, and with a large saving of water, an item particularly to be considered upon the canal.

THE ERIE CANAL.

The Erie Canal navigation is divided into three reaches—the Eastern, Middle, and Western Divisions.

THE EASTERN DIVISION.

This division of the canal extends from Albany to Higginsville, N. Y., a distance of one hundred and thirty-five miles, with 46 locks and a lockage of 426.96 feet; it also includes the side-cut locks at Troy for entering the Hudson at that place. The original surveys, plans, and estimates for gunboat-locks upon it were made in 1863, under the direction of Mr. D. C. Jenne, then engineer of the division, and to his report I am indebted for most of the data upon which I base these estimates, having carefully examined the various localities. It is proposed for this division to enlarge one tier of the present locks throughout its whole extent, except at Albany and West Troy; here it is found to be more favorable to enter the basins and river with locks upon new sites, and the estimates are based accordingly.

At the junction of the Erie and Champlain Canals, and at the Lower and Upper Mohawk aqueducts, it becomes necessary to enlarge the canal, and some slate-rock excavation is incurred, together with the removal of several buildings.

Removal of bench-walls.

During the past few years the removal of bench-walls, and substituting therefor slope and vertical walls extending to the canal-bottom, has been carried on rapidly. These walls reduce the capacity of the canal and interfere materially with navigation, and must all be removed. At this time, according to the report of the canal commis-

sioners of New York for 1874, there remains upon this division, for which contracts have not been made for removal, the following:

Upon the berme bank	20.51 miles
Upon the tow-path bank	21.69 miles

The removal of this is provided for in estimates.

Aqueducts.

The Lower Mohawk aqueduct, 1,132 feet long, the Upper Mohawk aqueduct, 607 feet long, and the Schoharie aqueduct, 627 feet long, are only 40 feet wide at the bottom, and will have to be widened in order that boats may pass each other; some of the others are but 50 feet in width, but are short; it is not deemed advisable to enlarge them, except where it becomes necessary for boats to enter a lock, as at Fulmer's Creek and Myers's Creek aqueducts, near locks Nos. 43 and 45.

Bridges.

One new bridge at Albany and three new chain-bridges at Troy will be necessary; the bridges in the vicinity of locks Nos. 22, 27, 30, and 46 require to be lengthened.

Culverts.

No changes will be required in the culverts now in use, except at the upper connection with the basin at West Troy, where it will be necessary to lengthen one.

Deepening canal.

Estimates have been prepared for obtaining a depth of 8 feet throughout this division, except upon mechanical structure; steam-power will, ere long, be used entirely upon the canals, and it is desirable to offer every possible facility for the rapid progress of boats.

THE MIDDLE DIVISION.

This division embraces a number of reservoirs and navigable feeders, and is the shortest division of the line of the Erie Canal. It extends from Higginsville, twelve miles west of Rome, on the long level, to the Wayne County line, a total distance of seventy-two miles, with six locks and a lockage of 50.42 feet.

Locks, bridges, and culverts.

It is proposed to enlarge the locks on the berme side throughout this division. The original estimates were made in 1864, under direction of Mr. J. P. Goodsell, then division engineer, and the data for the estimates now submitted were taken from his report, the localities having been carefully examined. Since 1864, one of the double locks and two single ones upon this division have been widened to 20 feet, and loaded boats have since been passed much more rapidly. No culverts will require to be disturbed, and but one bridge, at Syracuse, will require change.

Removing bench-walls.

The bench-walls upon this division must also be all removed, and slope and vertical walls extending to the canal-bottom substituted for them. At this time there remains to be removed, according to the report of the canal commissioners for 1874, the following, for the removal of which no contracts have been made:

Upon the berme side	13.01 miles.
Upon the tow-path side	1.31 miles.

The removal of these has been provided for in these estimates.

THE WESTERN DIVISION.

This division extends from the eastern line of Wayne County, N. Y., on the Montezuma, or lowest level, to Lake Erie, a distance of 144.78 miles, with nineteen lift-locks and a rise of 177.42 feet. There are two guard-locks and also two lift-locks connecting the canal with Niagara River.

Locks.

The original surveys, plans, and estimates for the locks proposed for passing gunboats from the Hudson River to Lake Erie were made under the direction of Mr. C.

W. Story, division engineer, in 1864, and to his report I am indebted for a great portion of the data from which my estimates are made, the localities having been carefully examined previous to preparing this report.

When these surveys were made in 1864 there were only six double locks upon this division, five of which were at Lockport and the other, No. 61, at Macedon; since that time extensive operations have been in progress, and at present all the locks are either double or in process of being doubled. Approximate estimates are therefore presented, based upon calculations for similar structures in similar localities, allowance being made for materials now in the locks.

It is proposed to enlarge, throughout the division, one of the double lift-locks, except at Lockville and Lockport.

Lockville.

Mr. Story recommends in his report that the line of the canal at Lockville be changed by making a new cut three-quarters of a mile long, and using two locks of 12 feet each, instead of the present three; this will necessitate considerable expense, but the benefit derived will more than compensate for the outlay. The new route is located north of the present canal, and avoids the curve; it has been adopted in this improvement, and the estimates based accordingly.

Lockport.

At present there is a double tier of five combined locks at Lockport, and a raceway with a culvert-feeder over the falls. The canal engineers have given this subject much thought and study, and it is deemed best not to interfere with the present flight, but to construct upon the south side a new set, overcoming the fall with three locks of 18.6 feet lift, each. This will necessitate the construction of a new race and feeder; and to obviate the damage that might accrue from the swift current upon the present inclined plane, estimates have been made for a succession of drop-over breast-walls. This plan is certainly a most admirable one, and after a careful examination of the locality, it seems impossible to offer a single suggestion as to an improvement upon it. In the construction of a new flight, room would be left for the construction of another tier, should it be found necessary in the future.

Guard-lock at Sulphur Springs.

Five miles west of Lockport, Sulphur Spring guard-lock has been constructed to prevent damage from the sudden rise of Tonawanda Creek, and to overcome the great velocity incident thereto. It is proposed to constuct a new enlarged lock, to be placed in line of the present south space bulk-head.

Connections with Niagara River.

At Tonawanda, a new location, half a mile west of the present one, has been selected for the connection with Niagara River. The present ship-lock at Black Rock is 200 feet long by 37 feet wide, with a depth of from 11 to 14 feet on the miter-sill, depending upon the height of the water; it will be only necessary to lengthen it.

Bridges.

Most valuable and interesting data, in reference to bridges, are found in Mr. Story's report.

At lock No. 55 two bridges will require additional abutments and new superstructures; below lock No. 56 one abutment will require to be removed and rebuilt. Upon the new cut-off at Lockville there will be required one road-bridge, and in order to use the present canal for passing the intersection two new change-bridges, and the lengthening of the bridge at Newark, will be necessary; also, the rebuilding of an abutment, and construction of a new superstructure upon the present tow-path bridge, below the locks. The change-bridge below lock No. 61 will require lengthening. Two new iron bridges are proposed to replace the wooden one at Main street, Lockport; also a new wooden bridge over the proposed new race, and new superstructure upon the Cottage-street bridge. These localities have been examined, and show the care and ability displayed by the State engineers.

Aqueducts.

Careful survey has shown that the curve of the east end of the Rochester aqueduct is too short to pass boats of the enlarged size; provision is therefore made for widening and lengthening the curve.

Deepening the canal.

From Lockport to Black Rock, the canal has already a depth of 8 feet or over; from the Wayne County line to Lockport, the depth is from 7 to 7½ feet; estimates have been made for obtaining the required depth.

From the head of Black Rock Harbor to Buffalo, the width of the canal is only from 70 to 80 feet; through this narrow channel, nearly the whole supply for the Erie Canal, to the Montezuma level, has to be forced, and the large mills now on the pier at lower Black Rock Harbor use a great quantity of this supply.

The canal engineers of New York have given this subject careful study, and have devised a plan to remedy the difficulty.

The State engineer of New York, in his last annual report, after stating the difficulties I have mentioned, continues as follows:

"Another serious difficulty has been the low stages of water in the lake. In August 1871, the surface of the lake ranged from 18 to 26 inches below its usual height, and during the past season of navigation varied from 25 to 27 inches. On the recommendations of the division and resident engineers, and approval by Hon. John D. Fay, canal commissioner in charge, the canal board resolved to remedy these difficulties by changing the original work, and adopting a general plan for constructing the canal through Black Rock Harbor, so as to make it independent of that harbor and the supply for the mills; in fact, by means of division-banks or cribs, to form two channels—one for the canal, the other for the mills; the channel for the former to be about 125 feet wide, and through it the water for feeding the canal will pass, the prism being deepened, so as to leave navigation uninterrupted by low water in the lake."

Although this project is now being carried out by the State of New York, it was deemed best to add to this report an approximate estimate of the cost of completing it.

Cost of this project.

The total cost of the project for enlarging one tier of locks, and new structures at Lockville, Lockport, Albany, and West Troy, and for obtaining a depth of not less than eight feet, except upon mechanical structures between Albany and Buffalo, is, after a careful examination of the localities and revision of all data that could be obtained, presented, as follows:

ERIE CANAL.

Eastern division	$4,485,776 65
Middle division	817,269 20
Western division	2,440,274 70
Fish Creek feeder, referred to under head of "water-supply"	430,276 00
Total	8,173,596 55

ERIE CANAL WATER-SUPPLY.

The enlarged boat proposed to navigate the Erie Canal, as compared with the existing boat, has a tonnage ratio of 690 to 210, as shown by the neat formula of W. B. Taylor in his Canal Report of 1864. This will give to the new boat a tonnage capacity of nearly 3.28 times greater than that of the existing boat. It is stated by the canal commissioner in his annual report for 1874, page 186, that the daily traffic on the canal near Buffalo is accomplished by the use of one hundred boats, and he asserts that this statement is nearly verified by the lockage-record at Schenectady. Therefore, one hundred boats may be safely taken as the number of the existing class of boats making daily use of the navigation. A water-supply for one hundred boats of the contemplated capacity is therefore assumed as more than sufficient for the accommodation of all existing traffic, and enough for the prospective traffic of many years to come. The number 100 also simplifies any calculations and comparisons that may be requisite for any further examination of the subject.

The navigation remains open from 214 to 240 days; has been as few as 205 and 202 days, and as many as 269 days. A fair average season is about 210 days, as obtained from the records of nearly fifty years, extending from the year 1824 to 1873. This information is taken from the Canal Commissioner's Report for 1874.

The following results have been obtained by using the foregoing information as a part of the necessary data, and they show an ample water-supply for the proposed canal enlargement, viz:

The natural divisions of the canal between Buffalo and Albany, for the purpose of showing the comparative sufficiency of supply for each, are arranged thus: (See diagram on tabular statement.)

From Buffalo to Lockport, a distance of thirty-one miles, is supplied by the Lake Erie head, direct. The supply being commensurate to the lake, of course this division requires no comment.

From Lockport to Rochester, about sixty-two miles, is a descending grade of $\frac{13}{1000}$ feet per mile. The water-supply on this reach is from Lake Erie, 35,000 cubic feet per minute; Oak Orchard Creek feeder, 1,400 cubic feet per minute; Genesee Canal (through lock), 861 cubic feet per minute; Genesee River, 350 cubic feet per minute—total, 37,611 cubic feet per minute. This abundant quantity is the supply as far as Clyde, a distance of forty-nine miles below Rochester, or one hundred and eleven miles from Lockport. This supply being direct from Lake Erie, the use of the additional feeders between Lockport and Rochester arrests attention. It appears that their intro-

duction is for the purpose of checking the current velocity created by the incline alluded to, and not directly for increasing the supply. The Genesee Canal quota, through lock, is an accidental increment, but it is also availed of for reducing the current velocity created by the incline. In the Canal Commissioner's Report for 1873, page 114, it is substantially stated that the mill-owners, who have a perpetual lease of the waters passing around Lockport, frequently use this water in excess of their requirements, and as it is discharged into the canal, at times proves unfavorable to navigation by increasing the velocity.

The Montezuma level, extending from Clyde to Port Byron, a distance of twenty miles, being the lowest level between the long level and Lake Erie, and being fed from two sources, has necessarily a sufficient supply. Its surplus is delivered into the Cayuga Canal. There never was any impediment to navigation on this level.

The Port Byron and the Jordan levels extend from Port Byron to Geddes, a distance of about twenty-two miles, and are, like the long level, dependent on special feeders, which appear to be abundantly sufficient. Apprehensions have been entertained for the supply of these levels, but the surplus supply, as shown in the accompanying "tabular statement," indicates that such apprehensions are certainly groundless.

The feeders of this division are:

Owasco Lake	10,267	cubic feet per minute.
Of this the millers claim	5,612	cubic feet per minute.
Balance owned by New York State	4,655	cubic feet per minute.
Putnam Creek feeder	200	cubic feet per minute.
Nine-mile Creek feeder	800	cubic feet per minute.
Carpenter Brook	200	cubic feet per minute.
Skaneateles Lake	8,767	cubic feet per minute.
Otisco Lake	5,145	cubic feet per minute.
Total	19,767	cubic feet per minute.

equal to 28,464,480 cubic feet per 24 hours.

After making the usual deductions from this daily supply, there remains, over and above the requirements of navigation, a surplus of 8,500,000 cubic feet (in round numbers) per 24 hours. This is fortunate, because the whole of the rain-basin in which this subdivision of the canal is located is already availed of for the purpose of supply, and there is no ordinary way of supplying any additional natural feed. (See chart.)

That portion of the canal *from Geddes*, embracing Syracuse and continuing *to the* west end of the *long level*, a distance of about three miles, is similar (as to situation) to the Montezuma level. It is fed from the long level on the east and from the Jordan level on the west. These feeding-levels having a large surplus, it follows that this comparatively short division will always have a sufficiency of water. On this level at Syracuse, the connection with Lake Ontario is made through the Oswego Canal.

The *long level*, extending easterly from the last-described division to Utica, a distance of about 55 miles, is supplied as follows, viz:

	Cubic feet per minute for the season.
Butternut Creek, Orville feeder	500
De Ruyter, through Limestone Creek, 3,891 cubic feet per minute for 100 days; Limestone Creek, 500 cubic feet per minute for 100 days	2,195
Erieville reservoir and Chittenango feeder, 2,526 cubic feet per minute for 100 days	1,263
Cazenovia Lake reservoir, 3,115 cubic feet per minute for 100 days	1,507
Cowaselon Creek feeder	320
Oneida Creek feeder	1,500
Delta feeder, through Black River canal-lock	1,294
Wood Creek, at Rome	125
Mohawk feeder	11,766
Butt's Creek feeder, 2½ miles east of Rome	1,400
Oriskany Creek feeder	4,561
Jamesville reservoir, 2,000 cubic feet per minute for 60 days	600
Total per minute	27,031

An additional supply from Fish Creek was contemplated, and the project matured so far as to have plans and estimates furnished for its construction. The work, however, has not been executed. Should there, by any contingency, be an increase wanted, this feeder will give a flow of 7,400 cubic feet per minute, exclusive of filtration and evaporation. An estimate for its construction is hereto appended. It has been intimated by the canal officers that this level is subject to great disturbance during the prevalence of strong westerly winds; that under such influences oscillations to the extent of 9 inches are frequently observed, making navigation on the western end quite difficult, and sometimes grounding the boats. There is an erroneously-formed opinion

as to the prospective insufficiency of water for this level. This opinion has taken form principally, if not altogether, from incidental causes, such as some break occurring or reservoir-dam giving way, and thus temporarily intercepting the ordinary supply, and causing boats to crowd on each other in passing through the long level. These drawbacks are being remedied by a better class of structures.

The next and last water-division, extending from Utica to the Hudson River at Albany, is about 110 miles long, with 45 locks, with an aggregate descent of $423\frac{46}{100}$ feet, making a mean descent for each lock of $9\frac{411}{1000}$ feet. This reach being similar in character to that from Rochester to Clyde (that is, all descent), the theoretic quantity of one lockage is the assumed requirement for the carriage of one boat through all the locks.

The supply is obtained through the following feeders, viz:

Ilion Creek	800	cubic feet per minute.
Mohawk, at Little Falls	12,643	cubic feet per minute.
Rocky Rift	10,602	cubic feet per minute.
Schoharie Creek feeder	6,800	cubic feet per minute.
Roxford feeder	10,979	cubic feet per minute.
Mohawk, at Cohoes	6,570	cubic feet per minute.
Total	48,394	cubic feet per minute,

equivalent to 69,687,300 cubic feet per 24 hours.

In this approximation of the quantity of water available for navigation the size of lock is taken at 225 feet × 26 feet × the corresponding lift, or mean of several lifts, as the case may be, and this quantity only is called the lockage; the percentage for waste and leakage through the gates being considered sufficient to cover the small quantity of water comprising the sheet existing between the boat and lock-walls when a boat is entered. The amount for filtration and evaporation is taken at 200 feet per mile per minute. Where a series of locks is to be considered, the mean lift is taken, and where two lockages are wasted, as on the long level, the sum of the two lifts is used. It is further assumed that the boats may pass through the locks in the most desultory order, so that if the supply is sufficient to fulfill these conditions the most skeptical should be convinced of the completeness and sufficiency of the whole water-supply.

The accompanying tabular statement gives the supplies, filtration, and lockage-waste, net available supply, and amount needed to pass one hundred boats in twenty-four hours, together with the surplus water after accomplishing such passage, each of which results is obtained in the manner stated.

It is understood that if two boats, going in opposite directions, meet at the same lock, then one lockage will pass the two boats; and if this were uniformly the case, the quantity of water stated in "the table" as necessary to pass one hundred boats will be sufficient to pass two hundred boats.

This state of things is never realized completely, but it is of so frequent occurrence, that in practice it is safe to assume that two lockages will pass three boats. On this assumption, the conclusion that the daily volume of water stated as the requirement for the passage of one hundred boats may be relied on to pass one hundred and fifty boats. Then one hundred and fifty boats, each of 690 tons, gives a daily movement of 103,500 tons, with the expenditure of water set forth in the tabular statement.

Tabular statement of water-supply of Erie Canal from Buffalo to Albany.

Water-divisions of the Erie Canal.	Distance in miles.	Furnished by feeders in 24 hours.	Filtration, evaporation, and leakage, in 24 hours.	Net available supply for 24 hours.	Required for 100 lockages per 24 hours.	Surplus water for 24 hours.
		Cubic feet.	*Cubic feet.*	*Cubic feet.*	*Cubic feet.*	*Cubic feet.*
Buffalo to Lockport, including Lockport lockage.	31	Extension of Lake Erie head.	Made up by Lake Erie.	Lake Erie head.	Not essential to consider.	Lake Erie.
Lockport to Rochester	62	54,159,840	....	....	....	....
Lockport to Clyde	111	54,159,840	33,547,500	20,612,340	5,265,000	15,347,340
Montezuma level	20	Supply from levels both ways.	5,760,000	....	....	....
Port Byron and Jordan levels	22	28,464,480	9,480,390	18,984,090	10,481,300	8,502,790
Geddes to Lodi lock, near Syracuse.	3	Supply from levels both ways.	864,000	....	....	....
Long level, from near Syracuse to Utica.	55	38,924,640	18,209,250	20,715,390	7,897,500	12,817,890
Utica to Albany	110	69,687,360	33,340,800	36,346,560	5,536,000	30,810,560

GENERAL REMARKS.

Schedules, comprising estimates in detail of several of the locks, are attached to this report. The estimate for Fish Creek feeder is also appended. Amplification is avoided as much as possible, and, in furtherance of this principle, the details of locks, bridges, aqueducts, culverts, section-work, and other miscellaneous structures, which would unavoidably make this report unnecessarily voluminous, are excluded.

COST OF TRANSPORTATION.

Upon the vital point of this improvement, the cost of transportation, it is noticeable that at the time the enlargement of the Erie Canal was authorized (May 11, 1835) the engineers who fixed the dimensions of the prism and size of the locks estimated that the enlargement would enable the carrier to reduce the cost of transportation fifty per cent. John B. Jarvis made a thorough investigation of the subject, and reduced it to a mathematical certainty. After a detailed statement, showing the progressive advance of commerce on the Erie Canal, at various periods, with the relative cost of transportation, and the cost per ton per mile, on all the canals for a series of years, State Engineer Taylor, in his report upon the enlargement for gunboats, gives the following result, which is a marked confirmation of J. B. Jarvis's conclusions:

Cost of transportation by old boats	4.16	mills per ton per mile.
Cost of transportation by existing boats	2.16	mills per ton per mile.
Cost of transportation by proposed enlarged boats	1.4	mills per ton per mile.

equivalent to a reduction of 50 per cent. in the cost of transportation by enlarging the locks to 225 feet between hollow quoins, and increasing the width of chamber to 26 feet at water-line.

The boats now in use on the canal have superseded the old ones, and if the proposed enlarged locks are constructed, the large boats will in like manner supersede those now in use. Those now existing could not successfully compete with boats of over three times their tonnage. Hence, the increasing demands of commerce and the advance of improvements will render the present boats inadequate, and the requirements of navigation will call for a commensurately-sized boat.

Taking into consideration the various views expressed in the several statements I have quoted from the reports of the gentlemen who have been for many years and in many ways identified with the public works of the State of New York, and under whose directions special investigations were made in the year 1864 for the then contemplated improvement of the Erie Canal, after having made a personal inspection of the most important localities on the line, and having made a thorough revision of the several proposed plans of location for the enlarged locks and other structures; also, having given a great deal of consideration to the prevailing influences that from time to time have been directed to the improvement of this canal, it is incumbent on me to state that the proposed work should be planned with a view to a complete enlargement of all the locks and structures where required.

In most instances one of the existing double locks should be enlarged, unless a new location be adopted for improving the line of canal.

With regard to the estimates, I have relied, generally, upon the data afforded by the actual surveys and measurements furnished by the State engineers of 1863 and 1864, carefully revising these data after examination of localities, and basing my prices upon those now paid for labor and materials. I have been associated with these State engineers for a number of years on the public works of that State, and should my opinion have any weight in this regard, I have no hesitation in saying that they are men of experience in their profession, whose statements are perfectly reliable.

The estimates are made for locks and all other stone structures, built of well-dressed limestone, laid in hydraulic cement, and I should recommend each work of its class to be constructed of the best materials and workmanship.

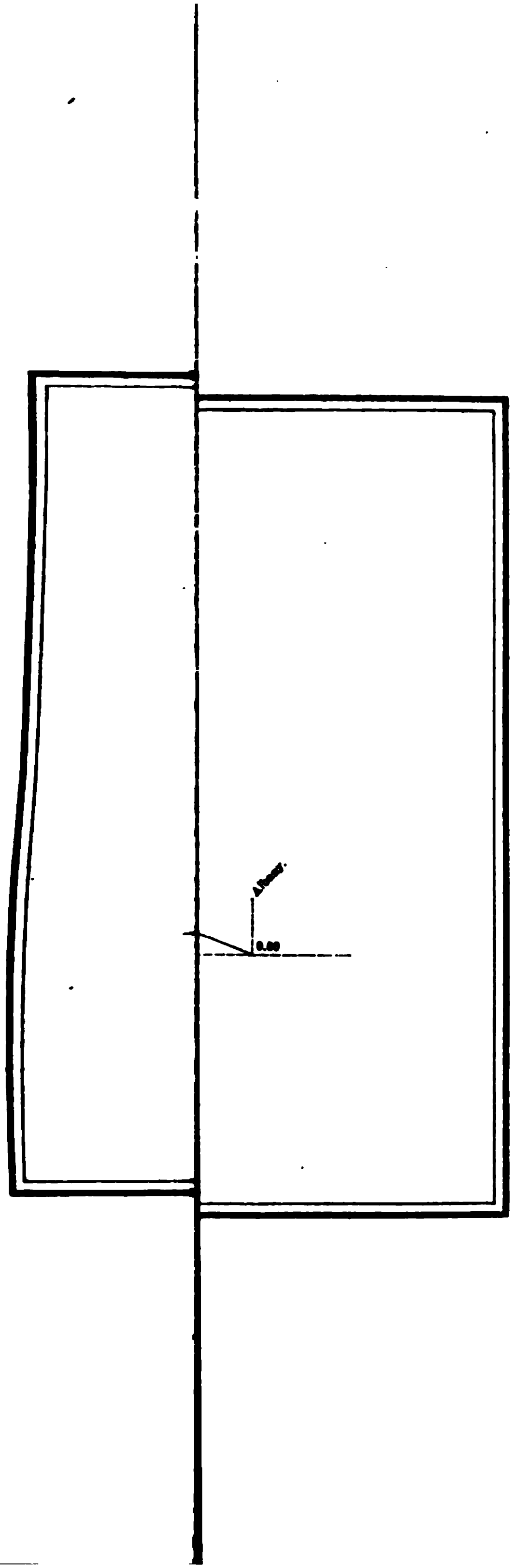
A work of such importance should be carried out in the most substantial manner, and there should be as little resort as possible to the use of wood for the principal aqueducts and bridges connected with this project.

In closing these remarks, I would consider my task unfinished should I not give Mr. Martin King, assistant engineer, due credit for the valuable assistance I have received from him, and particularly for the "statement of water-supply," and for preparing the chart, plans, and other drawings accompanying this report.

Very respectfully, your obedient servant,

OCTAVE BLANC,
Assistant Engineer.

Maj. JOHN M. WILSON,
Corps of Engineers, Brevet Colonel, U. S. A.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EASTERN DIVISION.

Detailed estimate for enlarging one of the present locks.

Items.	Lock No. 6, 10 feet lift.		
	Quantity.	Price.	Amount.
Grubbing and clearing			$200 00
Bailing and draining			2,000 00
Excavation of earth ... cubic yards.	4,900	$0 28	1,372 00
Excavation of old lock-walls ... do	1,263	1 50	1,894 50
Embankment ... do	3,000	28	840 00
Lining ... do	1,550	50	775 00
Puddling of earth ... do	400	30	120 00
Loose stones ... do	90	1 50	135 00
Vertical wall, in cement ... do	120	6 00	720 00
Vertical wall, dry ... do	70	3 00	210 00
Masonry in lock-walls ... do	2,833	13 00	36,829 00
Concrete masonry ... do	300	5 00	1,500 00
White-oak timber, &c ... feet, board-measure	34,000	60 00	2,040 00
White-pine timber ... do	16,500	45 00	742 50
Hemlock timber ... do	124,700	20 00	2,494 00
Bearing-piles ... linear feet	12,700	15	1,905 00
Bearing-piles, driven ... do	10,000	10	1,000 00
Wrought iron ... pounds.	16,400	12	1,968 00
Cast iron ... do	11,850	8	948 00
Spikes and nails ... do	4,000	6	240 00
Sulphur and sand cement ... per lock.	1	100 00	100 00
Painting lock-gates	1	30 00	30 00
Snubbing-posts ... linear feet.	100	60	60 00
			58,123 00
Deduct stone furnished ... cubic yards	840	6 00	5,040 00
			53,083 00

Items.	Lock No. 38, 9½ feet lift.		
	Quantity.	Price.	Amount.
Grubbing and clearing	1	$200 00	$200 00
Bailing and draining	1	2,500 00	2,500 00
Excavation of old lock-walls ... cubic yards.	1,278	1 50	1,917 00
Excavation of blasted rock ... do	9,100	1 00	9,100 00
Embankment ... do	2,800	28	784 00
Lining ... do	1,600	50	800 00
Puddling of earth ... do	370	30	111 00
Slope-wall and pavement ... do	30	2 00	60 00
Loose stone ... do	90	1 50	135 00
Vertical wall, in cement ... do	120	6 00	720 00
Vertical wall, dry ... do	290	3 00	870 00
Masonry in lock-walls ... do	2,743	13 00	35,659 00
Concrete masonry ... do	300	5 00	1,500 00
White-oak timber, &c ... feet, board-measure.	36,000	60 00	2,160 00
White pine ... do	16,400	45 00	738 00
Hemlock timber ... do	121,000	20 00	2,420 00
Wrought iron ... pounds	16,100	12	1,932 00
Cast iron ... do	11,850	8	948 00
Spikes and nails ... do	4,000	6	240 00
Sulphur and sand cement ... per lock.	1	105 00	100 00
Painting lock-gates ... do	1	30 00	30 00
Snubbing-posts ... linear feet	100	60	60 00
			62,984 00
Deduct stone furnished ... cubic yards.	860	5 00	5,160 00
			57,824 00

Summary estimate, eastern division.

Lock No. 1, 15¼ feet lift	$100,432 00
Lock No. 2, 9⅞ feet lift	68,402 30
Lock No. 3, 11¼ feet lift	61,026 00
Lock No. 4, 11¼ feet lift	60,425 00
Lock No. 5, 10⅜ feet lift	52,964 00
Lock No. 6, 10 feet lift	53,083 00
Lock No. 7, 10 feet lift	53,191 50
Lock No. 8, 10 feet lift	56,617 00

Lock No. 9, 10 feet lift	$59,320 00	
Lock No. 10, 10 feet lift	53,159 00	
Lock No. 11, 10 feet lift	55,763 00	
Lock No. 12, 10 feet lift	57,079 00	
Lock No. 13, 10 feet lift	51,560 00	
Lock No. 14, 10 feet lift	50,021 00	
Lock No. 15, 10 feet lift	52,662 50	
Lock No. 16, 10 feet lift	55,922 00	
Lock No. 17, 10 feet lift	52,798 50	
Lock No. 18, 10½ feet lift	61,068 50	
Lock No. 19, 8½ feet lift	47,170 50	
Lock No. 20, 10 feet lift	54,471 25	
Lock No. 21, 11½ feet lift	59,810 75	
Lock No. 22, 11½ feet lift	54,176 00	
Lock No. 23, 8 feet lift	51,306 00	
Lock No. 24, 8 feet lift	50,212 75	
Lock No. 25, 8 feet lift	50,698 00	
Lock No. 26, 8 feet lift	49,767 00	
Lock No. 27, 8 feet lift	46,521 50	
Lock No. 28, 8 feet lift	50,644 50	
Lock No. 29, 7½ feet lift	42,585 00	
Lock No. 30, 10½ feet lift	51,689 50	
Lock No. 31, 6 feet lift	43,915 00	
Lock No. 32, 8 feet lift	47,995 00	
Lock No. 33, 6 feet lift	43,052 50	
Lock No. 34, 8 feet lift	47,674 00	
Lock No. 35, 8 feet lift	47,429 50	
Lock No. 36, 10 feet lift	50,003 50	
Lock No. 37, 10 feet lift	61,798 00	
Lock No. 38, 9½ feet lift	57,824 00	
Lock No. 39, 10½ feet lift	57,449 00	
Lock No. 40, 8 feet lift	46,308 00	
Lock No. 41, 8 feet lift	45,521 00	
Lock No. 42, 8 feet lift	51,118 50	
Lock No. 43, 8 feet lift	51,110 50	
Lock No. 44, 10½ feet lift	54,945 50	
Lock No. 45, 10½ feet lift	52,836 75	
Lock No. 46, 3 feet lift	42,015 50	
Upper lock at West Troy, 11 feet lift	82,163 50	
Lower lock at West Troy, 13 feet lift	92,664 00	
		$2,640,370 80
Enlarged aqueducts:		
Schoharie aqueduct	32,726 00	
Pulmer's Creek aqueduct	7,082 00	
Myers's Creek aqueduct	8,240 00	
Lower Mohawk aqueduct	60,215 00	
Upper Mohawk aqueduct	30,815 00	
		139,078 00
Bridges:		
Bridge over lock No. 1	8,134 50	
Bridge at foot of lock No. 22	3,021 50	
Bridge at foot of lock No. 27	1,974 75	
Bridge at foot of lock No. 30	5,830 00	
Bridge at foot of lock No. 46	2,743 00	
Change-bridge head of upper side-cut lock	3,909 00	
Change-bridge head of lower side-cut lock	3,377 50	
Change-bridge foot of lower side-cut lock	2,243 00	
		31,233 25
Culverts:		
Lengthening culverts	1,599 00	
		1,599 00
Removal of bench-walls:		
Excavation of earth slope-wall, and slope-wall rebuilt	552,000 00	
Enlarging canal at various points	9,925 00	
		561,925 00
Deepening canal one foot	626,500 00	
		626,500 00
		4,000,706 05

Summary estimate for enlarging one of the present locks, eastern division.

Locks Nos. 1 to 46. inclusive, and two locks at West Troy.	$2,640,370 80	
Enlarging aqueducts	139,078 00	
Bridges	31,233 25	
Culverts	1,599 00	
Removal of bench-walls, &c	552,000 00	
Enlarging canal at various points	9,925 00	
Deepening canal one foot	626,500 00	
		$4,000,706 05
Add 10 per cent. for engineering and contingencies	400,070 60	
Land damages and removal of buildings	85,000 00	
		485,070 60
		4,485,776 65

MIDDLE DIVISION.

Estimates for enlarging one of the present locks.

Lock No. 47, $10\frac{1}{4}$ feet lift	$66,927 00	
Lock No. 48, $10\frac{1}{4}$ feet lift	64,849 00	
Lock No. 49, 6 feet lift	55,546 00	
Lock No. 50, $6\frac{11}{12}$ feet lift	55,595 00	
Lock No. 51, $5\frac{1}{4}$ feet lift	53,571 00	
Lock No. 52, 11 feet lift	71,000 00	
		$367,488 00
Removing bench-walls	158,000 00	
Bridge at lock No. 49	7,343 00	
Deepening canal one foot	210,141 00	
		375,484 00
		742,972 00
Add 10 per cent. for engineering and contingencies		74,297 20
		817,269 20

WESTERN DIVISION.

Detailed estimate for enlarging one of present locks.

Items.	Lock No. 61, 7 feet lift.		
	Quantity.	Price.	Amount.
Grubbing and clearing			$100 00
Bailing and draining			3,000 00
Earth excavation ... cubic yards	9,000	$0 28	2,520 00
Rock excavation ... do	700	1 00	700 00
Excavation of old lock-walls ... do	1,250	1 50	1,875 00
Embankment ... do	2,000	28	560 00
Puddling ... do	2,200	30	660 00
Lining ... do	1,200	50	600 00
Slope-wall ... do	250	2 00	500 00
Rubble-wall, in cement ... do	200	6 00	1,200 00
Loose stone ... do	400	1 50	600 00
Masonry in lock-walls ... do	2,320	13 00	30,160 00
Concrete ... do	300	5 00	1,500 00
Oak ... feet, board measure	31,200	60 00	1,872 00
Pine ... do	12,000	45 00	540 00
Hemlock ... do	94,000	20 00	1,880 00
Wrought iron ... pounds	11,400	12	1,368 00
Cast iron ... do	7,900	8	632 00
Spikes ... do	3,000	6	180 00
Sulphur, sand, and cement ... per lock	1		100 00
Painting lock-gates ... do	1		30 00
Snubbing-posts ... linear feet	100	60	60 00
			50,637 00
Less 870 cubic yards stone in locks, at $6 per cubic yard			5,220 00
			45,417 00

Detailed estimate of combined locks at Lockport.

Items.	Two combined locks on new line at Lockville, each 12 feet lift.		
	Quantity.	Price.	Amount.
Grubbing and clearing	....	$100 00	$100 00
Bailing and draining	....	2,000 00	2,000 00
Earth excavation ..... cubic yards	71,000	28	19,880 00
Embankment ..... do	40,000	28	11,200 00
Lining ..... do	12,000	50	6,000 00
Puddling ..... do	12,000	30	3,600 00
Slope-wall ..... do	3,700	2 00	7,400 00
Loose stone ..... do	400	1 50	600 00
Pavement of quarried stones, grouted ..... do	320	3 00	960 00
Rubble wall, in cement ..... do	900	6 00	5,400 00
Masonry in lock-walls ..... do	7,840	13 00	101,920 00
Masonry in culverts and wells ..... do	800	13 00	10,400 00
Concrete masonry ..... do	600	5 00	3,000 00
White-oak timber ..... feet, board measure	62,000	60 00	3,720 00
White-pine timber ..... do	39,000	45 00	1,755 00
Hemlock timber ..... do	473,000	20 00	9,460 00
Wrought iron ..... pounds	19,000	12	2,280 00
Cast iron ..... do	16,400	8	1,312 00
Spikes and nails ..... do	8,000	6	480 00
Lead ..... do	400	12	48 00
Painting ..... per structure	....	60 00	60 00
Sulphur and sand cement ..... do	....	200 00	200 00
Snubbing-posts ..... linear feet	200	60	120 00
Total	....	....	191,895 00

Detailed estimate of combined locks at Lockville.

Items.	Three combined locks, Nos. 67-71, each 18 6-10 feet lift, at Lockport.		
	Quantity.	Price.	Amount.
Grubbing and clearing	....	$450 00	$450 00
Bailing and draining	....	5,000 00	5,000 00
Earth excavation ..... cubic yards	25,000	28	7,000 00
Rock excavation ..... do	30,000	1 00	30,000 00
Excavation of old cement walls ..... do	2,000	1 50	3,000 00
Embankment ..... do	8,000	28	2,240 00
Puddling ..... do	4,000	30	1,200 00
Lining ..... do	4,000	50	2,000 00
Loose stone ..... do	1,000	1 50	1,500 00
Pavement of quarried stone, grouted ..... do	200	3 00	600 00
Rubble wall, laid dry ..... do	1,200	3 00	3,600 00
Rubble wall, in cement ..... do	740	6 00	4,440 00
Masonry in lock-walls ..... do	20,700	13 00	269,100 00
Masonry in concrete ..... do	1,500	5 00	7,500 00
White-oak timber ..... feet, board measure	80,000	60 00	4,800 00
White-pine timber ..... do	50,000	45 00	2,250 00
Hemlock timber ..... do	500,000	20 00	10,000 00
Wrought iron ..... pounds	31,000	12	3,720 00
Cast iron ..... do	28,000	8	2,240 00
Spikes and nails ..... do	15,000	6	900 00
Lead ..... do	1,800	12	216 00
Painting ..... per structure	....	100 00	100 00
Sulphur and sand cement ..... do	....	150 00	150 00
Bearing and protecting piles ..... linear feet	21,000	25	5,250 00
Snubbing-posts (stone) ..... do	300	1 50	450 00
Iron railing ..... do	580	7 00	4,060 00
Total	....	....	371,766 00

Estimate for enlarging present locks, and constructing new tier at Lockport and cut-off at Lockville.

Lock No. 53, 5 feet lift	$56,109 00
Lock No. 54, 7½ feet lift	58,002 00
Lock No. 55, 6 feet lift	58,593 00
Lock No. 56, 10 feet lift	66,982 00
Locks No. 57–59, two locks, each 12 feet lift	191,895 00
Lock No. 60, 10 feet lift	67,482 00

Lock No. 61, 7 feet lift	$45,417 00	
Lock No. 62, 9 feet lift	53,475 00	
Lock No. 63, 9 feet lift	51,226 00	
Lock No. 64, 10 feet lift	65,598 00	
Lock No. 65, 10 feet lift	61,451 00	
Lock No. 66, 9 feet lift	64,288 00	
Locks No. 67–71, three combined, each 18$\frac{6}{10}$ feet lift	371,766 00	
Sulphur-spring guard-lock	48,627 00	
River-lock at Tonawanda	80,411 00	
Black Rock guard-lock	53,145 00	
Ship-lock at Black Rock	19,386 00	
		$1,413,853 00
New culvert at Lockville, and culvert and race at Lockport	50,579 00	
Enlarging aqueduct	62,945 00	
Bridges	58,000 00	
New tow-paths	13,000 00	
		184,524 00
Deepening canal one foot		524,000 00
		2,122,977 00

SUMMARY OF WESTERN DIVISION.

Enlarging one tier of present locks and new locks at Lockport and Lockville.

Locks	$1,413,853 00	
Culverts and race	50,579 00	
Aqueducts	62,945 00	
Bridges	58,000 00	
Tow-paths	13,000 00	
Deepening canal from Wayne County line to Lockport, and improving channel between Black Rock and Buffalo	524,600 00	
		$2,122,977 00
Add 10 per cent. for engineering and contingencies	212,297 70	
Land damages and removal of buildings	105,000 00	
		317,297 70
		2,440,274 70

EASTERN DIVISION.

Detailed estimate of Fish Creek feeder, Erie Canal.

Items.	Quantities.	Price.	Amount.	Total amount.
Section-work.				
Grubbing and clearing ... miles.	11	$400 00	$4,400 00	
Bailing and draining ... do.	11	100 00	1,100 00	
Excavation of earth ... cubic yards.	920,600	20	184,000 00	
Excavation of rock ... do.	1,000	1 00	1,000 00	
Embankment ... do.	610,000	25	152,500 00	
Lining ... do.	5,000	50	2,500 00	
Puddling earth ... do.	3,000	30	900 00	
Slope-wall ... do.	2,000	2 00	4,000 00	
Vertical wall in cement ... do.	200	5 00	1,000 00	
Vertical wall, dry ... do.	800	3 00	2,400 00	
Hemlock timber ... feet, board-measure.	20,000	20 00	400 00	
				$354,200 00
Mechanical structures.				
Box-culverts	9	1,620 00	14,580 00	
Extension of railroad-culvert	...	...	5,857 00	
Railroad-viaduct	...	...	939 00	
Culvert at Station 386	...	...	2,250 00	
East Branch aqueduct	...	...	19,500 00	
Wood Creek aqueduct	...	...	7,500 00	
Canada Creek aqueduct	...	...	4,500 00	
Dam across West Branch	...	...	7,500 00	
Dam across East Branch	...	...	3,750 00	
Culvert at Beaver Creek	...	...	2,700 00	
Bridges	25	202 00	5,050 00	
Drop into canal	...	...	1,950 00	
				76,076 00
Total	...	...	...	430,276 00

GENERAL SUMMARY.

Estimate for enlarging one tier of present locks with new locks at Lockport and Lockville, and deepening canal one foot.

Eastern division	$4,485,776 65
Middle division	817,269 20
Western division	2,440,274 70
Fish Creek feeder	430,276 00
Total	8,173,596 55

ONEIDA SHIP-CANAL ROUTE.

REPORT OF JAMES S. LAWRENCE, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Oswego, N. Y., December 20, 1874.

COLONEL: In accordance with instructions contained in your letters of the 3d and 7th of August last, directing me to make a reconnaissance of the line of the proposed Oneida ship-canal, and to prepare an estimate of the cost of its construction, I have the honor to submit the following report, with estimates for the same:

REPORT.

The greater portions of the months of August and September were employed in making examinations of the route and obtaining data for an estimate for the construction of the Oneida ship-canal.

I obtained much valuable information at the office of the State engineer at Albany, and also from the division and resident engineers at Syracuse and Fulton; but after the expenditure of much time in the search for information, I found it necessary to put parties into the field to make measurements and cross-sections along the Oswego and Erie Canals, without which I could not have made a reliable estimate of the cost of the work. For that portion of the line from Oswego to Oneida Lake, Mr. M S. Kimball, of Fulton, the resident engineer in charge of the Oswego Canal, supplied me with valuable information, maps, profiles, and papers.

For that portion of the Erie Canal between Durhamville and Albany and the Oneida Canal, now under construction from Durhamville to Oneida Lake, much valuable information, together with plans, maps, and profiles, was obtained from the offices of the division engineer at Syracuse and the State engineer at Albany.

I am also indebted to Mr. Martin King, assistant engineer, for his valuable assistance in the preparation of that part of the estimate relating to the water-supply, calculations of quantities in the enlargement of aqueducts, and for the making of maps and plans accompanying this report.

To Mr. W. P. Judson, assistant engineer, I am also indebted for valuable assistance in making surveys of the canal at Cohoes and Albany, and estimates of the work to be done at those places; also for the calculations of quantities required in the enlargement and rebuilding of culverts, waste-weirs, &c.

Valuable information has been obtained from the State engineer's annual reports, especially that of 1864, on the enlargement of the locks and canals for the passage of gunboats.

The distance from Oswego to Albany by the shortest line is 200.447 miles. By taking the Oswego and Oneida River line a saving of about a million dollars may be made, but the distance would be increased to 207.935 miles. The shortest line is therefore recommended.

The prism of the proposed canal is 140 feet at the surface of water, 120 feet at the bottom, and 10 feet deep.

The locks are 185 feet long, 29 feet wide, and 9 feet of water on the miter-sill.

	Feet.
The ascent from Lake Ontario (Oswego) to the summit-level at Durhamville is	181.81
Descent from Durhamville to Albany	426.96
Total lockage, ascending and descending	608.77

The canal is to be constructed on the line of the Oswego Canal and slack-water navigation by widening and deepening the canal to the required dimensions, and dredging and improving the reaches of slack-water navigation to Brandy Brook culvert, one-half mile below Phœnix and 20.5 miles from Oswego.

From Brandy Brook culvert a short cut is taken to a bend in the Oneida River, at Peter Scott's swamp, a distance of 2.763 miles; from thence along the Oneida River, for a distance of 8.005 miles (which is to be dredged and improved where required), to a point near the mouth of Black Creek; thence by another short-cut line, 2.125 miles, to a point in the Oneida River near Brewerton; and from thence along the river to Oneida Lake, a distance of 1.253 miles.

From Brewerton the navigation will be continued through the Oneida Lake, 21.339 miles, to the Oneida Canal (which will be enlarged to the size required), a distance of 5.082 miles, to its junction with the Erie Canal at Durhamville, 61.067 miles from Oswego.

Durhamville, at the junction of the Oneida and Erie Canals, is situated nearly midway of the Rome, or long, level, which will be the summit-level of the proposed Oneida ship-canal.

From Durhamville to Little Falls the enlargement can be made at a moderate outlay, there being no difficult or costly work to be done; but at Little Falls much expensive work occurs, involving the removal of a large amount of solid work to obtain the required width of canal.

From Little Falls to the Upper Mohawk aqueduct the work is of the ordinary kind, and not of an expensive character; but at the lower end of the aqueduct, and near locks 22 and 23, heavy rock-cutting occurs, and continues for a considerable distance eastward.

A large amount of slope-wall will be necessary to protect the embankment from the wash of the Mohawk River, between the Upper and Lower Mohawk aqueducts; and a large amount of slate-rock must be removed in widening and deepening the canal.

At Cohoes slate-rock occurs, and a large amount must be removed to give the necessary width of canal at this place.

From Troy to Albany more slate-rock occurs, and a large amount must be removed.

A large amount of vertical wall must be built, and a channel dredged through the Albany Basin to lock No. 1.

LOCKS.

The locks are to be built in the best manner, of cut stone, and similar to the best-built locks on the Erie Canal.

AQUEDUCTS.

The Schoharie Creek aqueduct and Upper and Lower Mohawk aqueducts will be enlarged to 70 feet width of water-way, the piers and abutments extended, and an entire new trunk built for each. The smaller aqueduct will be enlarged to the width of the canal, the piers and abutments extended, and an entire new trunk built for each.

BRIDGES.

One new abutment is estimated for each bridge, and new superstructure for all, as the length of the new ones will be twice that of the present ones.

CULVERTS.

When the arch of the culvert is three feet or more below the present canal, it will be extended to the required length for the new canal; but where the crown of the arch would be above the bottom, it will be taken down and rebuilt of the required size.

WASTE-WEIRS

Will be rebuilt, and the valves and iron-work used in the new structures when found to be suitable.

VERTICAL AND SLOPE WALL.

Vertical wall will be built through cities and villages, and slope-wall on all other portions of the canal, except through rock-cuttings, where no protection to the sides of the canal will be required.

FISH CREEK FEEDER.

The quantities upon which this feeder is estimated were taken from the report of the New York State engineer for 1864.

WATER-SUPPLY.

In making this estimate, one hundred lockages per day have been determined on as sufficient for the present and prospective trade for some years to come, and it is generally admitted that in the ordinary course of trade two lockages will pass three boats. Provision will therefore be made for the passage each day of 150 boats, each boat having a capacity of 28,000 bushels of wheat when towed, and 25,000 bushels in boats or

barges when propelled by steam; and should the increase of trade on this canal demand it, there is ample means for an enlarged supply of water for its accommodation.

Commencing with the long level of the Erie Canal, between lock No. 46, at Utica, and lock No. 47 at Syracuse, which is 55.72 miles long, and will, when the prism of that portion between Durhamville and Utica is enlarged, contain 263,316,900 cubic feet of water, and will require 5.311 days to fill it, the supply for which will be obtained from the following feeders:

FEEDERS.

	Cubic feet per minute.
Butternut Creek, by the Orville feeder, for the season	500
DeRuyter reservoir, through Limestone Creek, 38,891 cubic feet per minute for 100 days; Limestone Creek, separate, 500 cubic feet per minute for 100 days; for the season	2,195
Erieville reservoir, 2,130 cubic feet per minute for 100 days; Chittenango feeder, 250 cubic feet per minute for 100 days; for the season	1,263
Cazenovia Lake reservoir, 3,115 for 100 days; for the season	1,507
Cowaselon Creek feeder	320
Oneida Creek feeder	1,500
Delta feeder, through Black River Canal	1,294
Wood Creek, at Rome	125
Mohawk feeder	11,766
Butt's Creek feeder, 2¼ miles east of Rome	1,400
Oriskany Creek feeder	4,561
Jamesville reservoir, for 60 days, 2,000 cubic feet, per season	600
Being 38,924,640 cubic feet in 24 hours	27,031
Proposed Fish Creek feeder	7,400
Being 49,580,640, cubic feet in 24 hours	34,431

Summit-level, between Syracuse and Utica.

The locks at the ends of the long level have a lift of 11 feet and 3 feet respectively.

	Cubic feet
The lockage, therefore, for 100 boats, per day, is 185′ × 29′ × 14′	7,511,000
Leakage, estimated at 30 per cent. of lockage	2,253,300
Filtration and evaporation on the enlarged canal: From Utica to Durhamville is 29.82 miles, and from Durhamville to Oneida Lake 5.08 miles: equal to 34.09 miles, at 3.80 cubic feet per mile per minute	19,097,280
From Durhamville to Syracuse, being that portion of the long level which is not to be enlarged, 26.62 miles × 200 cubic feet per mile per minute	7,666,560
Leakage and waste at two aqueducts	164,800
Total daily supply required	36,692,940
Total daily supply of water	49,580,640
Total daily supply required	36,692,940
Surplus daily	12,887,700

From lock 46, at Utica, to lock 34, east of Little Falls, a distance of 31.03 miles, the canal is supplied by two feeders, and the lockage and leakage from the summit-level at Utica are as follows:

			Cubic feet
One-half of the surplus from the summit-level for 24 hours			6,443,850
From one hundred lockages, 185 × 29 × 3=1,609,500		for 24 hours	2,092,350
Leakage of locks, 30 per cent	482,850		
Ilion feeder	800	13,443 cubic feet per minute	19,357,920
Mohawk feeder, at Little Falls	12,643		
Total daily supply			27,894,120
The water required for this portion of the canal is for one hundred lockages, 185 × 29 × 9, equals	4,828,500		6,277,050
Leakage of locks, 30 per cent	1,448,550		
Filtration and evaporation, 31.03 miles × 380 cubic feet per mile per minute			16,979,616
Leakage and waste at five aqueducts			276,000
Total required			23,532,666

	Cubic feet.
Total daily supply	27,894,120
Total daily supply required	23,532,666
Surplus	4,361,454

From lock 34, east of Little Falls, to lock 28, east of Schoharie Creek feeder, 30.47 miles, the supply is—

		Cubic feet per day.
Lockage and leakage from the upper level		6,277,050
Surplus water from the upper level		4,361,454
Rocky Rift feeder 10,602	17,402 cubic feet per minute	25,058,880
Schoharie Creek feeder 6,800		
Total daily supply		35,697,384
Required for one hundred lockages, 185 × 29 × 10½ = 5,633,250	per day.	7,323,225
Leakage of locks, 30 per cent 1,689,975		
Filtration and evaporation, 30.47 miles × 380 cubic feet per mile per minute		16,673,184
Leakage and waste at five aqueducts		968,800
Total required		24,965,209
Total daily supply		35,697,384
Total daily supply required		24,965,209
Surplus		10,732,175

From lock 28, east of Schoharie Creek feeder, to lock 19, 29.817 miles, the supply is:

	Cubic feet per day.
Lockage and leakage from the upper level	7,323,225
Surplus water from the upper level	10,732,175
Rexford feeder, 10,979 cubic feet per minute	15,809,760
Total daily supply	33,865,160
Required for 100 lockages, 185 × 29 × 11½ = 6,169,750; Leakage of locks, 30 per cent 1,850,925	8,020,675
Filtration and evaporation, 29.817 miles × 380 c. f. per mile per minute	16,315,862
Leakage and waste at four aqueducts	736,000
	25,072,537
Total daily supply	33,865,160
Total daily supply required	25,072,537
Surplus	8,792,623

From lock 19, west of Cohoes, to lock 3, at Troy, 12.162 miles, the supply is:

Lockage and leakage from the upper level	8,020,675
Surplus water from the upper level	8,792,623
Total daily supply	16,813,298
Required for 100 lockages, 185 × 29 × 11¼ = 6,035,625; Leakage of locks, 30 per cent 1,810,687	7,846,312
Filtration and evaporation, 12.162 miles × 380 c. f. per mile per minute	6,655,046
Leakage and waste at one aqueduct	904,000
Total required	15,405,358
Total daily supply	16,813,298
Total daily supply required	15,405,358
Surplus	1,407,940

	Cubic feet per day.
From lock 3, West Troy, to lock 1, at Albany Basin, 6.487 miles, the supply is:	
Lockage and leakage from the upper level	7,846,312
Surplus water from the upper level	1,407 940
From the Mohawk River, by the Champlain Canal, at its junction with the Erie Canal, 6,570 cubic feet per minute	9,460 800
Total daily supply	18,715 052
Required for 100 lockages, 185 × 29 × 15½ = 8,315,750; Leakage 30 per cent 2,494,725	10,810,475
Filtration and evaporation, 6,487 miles × 380 c. f. per mile per minute	3,549,686
Total required	14,360,161
Total daily supply	18,715,052
Total daily supply required	14,360,161
Surplus	4,354,891

Daily water supply and demand from Durhamville to Albany.

	Supply.	Demand.	Surplus.
Summit-level to Utica, lock 46	49,580,640	36,692,940	12,887,700
From Utica, lock 46 to lock 34	27,894,120	23,532,661	4,361,454
From lock 34 to lock 28	35,697,384	24 965,209	10,732,175
From lock 28 to lock 19	33,865,160	25,072,537	8,792,623
From lock 19 to lock 3	16,813,298	15,405,358	1,407,940
From lock 3 to lock 1, Albany	18,715,052	14,360,161	4,354,891

ESTIMATED COST OF THE ONEIDA SHIP-CANAL.

From Oswego to Durhamville by the river line.

For excavation of earth and rock, embankment, slope and vertical wall, culverts, bridges, aqueducts, waste-weirs, and towing-paths	$2,357,559 50	
Locks on the Oswego Canal, Oneida River, and Oneida Canal	1,741,611 00	
	4,099,210 50	
Ten per cent. for engineering and contingencies	409,921 05	
Land damages	452,320 50	
		$4,961,452 05

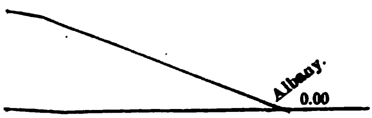
From Durhamville to Albany.

Excavation of earth and rock, embankment, slope and vertical wall, culverts, bridges, aqueducts, waste-weirs, and towing-paths	$12,203,607 00	
Locks, including side-cut locks at Troy	3,078,668 00	
Protection-walls on the Mohawk River	183,309 00	
	15,465,584 00	
Ten per cent. for engineering and contingencies	1,546,558 40	
Fish Creek feeder	430,276 00	
Land damages	1,847,842 00	
		19,290,260 40
		24,251,712 45

From Oswego to Durhamville by the cross-cut line.

For excavation of earth and rock, embankment, slope and vertical wall, culverts, bridges, aqueducts, waste-weirs, and towing-paths	$3,282,257 50	
Locks on the Oswego Canal, Oneida River, and the Oneida Canal	1,741,611 00	
	5,023,868 50	
Ten per cent. for engineering and contingencies	502,386 85	
Land damages	397,341 50	
		$5,923,596 85

by 55 Lift-Locks.



From Durhamville to Albany.

Excavation of earth and rock, embankment, slope and vertical wall, culverts, bridges, aqueducts, waste-weirs, and towing-paths	$12, 203, 607 00	
Locks, including side-cut locks at Troy	3, 078, 668 00	
Protection-wall on the Mohawk River	183, 309 00	
	15, 465, 584 00	
Ten per cent. for engineering and contingencies	1, 546, 558 40	
Fish Creek feeder	430, 276 00	
Land damages	1, 847, 842 00	
		$19, 290, 260 40
		25, 213, 857 25

	Distance in miles.	Total water-supply for 24 hours.	Filtration and evaporation for 24 hours.	Lockage for 100 boats for 24 hours.	Lockage and waste for 24 hours.	Navigation requirements for 24 hours.	Surplus for 24 hours.
		Cubic feet.	*Cub c feet.*	*Cubic feet*	*Cubic feet.*	*Cubic feet.*	*Cubic feet.*
Syracuse to Durhamville	26. 02	....	....	....	....	....	....
Durhamville to Utica	29. 811	49, 580, 640	26, 763, 840	7, 511, 000	2, 418, 100	36, 692, 940	12, 887, 700
Lock 46 to lock 34	31. 030	27, 894, 120	16, 979, 616	4, 828, 500	1, 724, 550	23, 532, 660	4, 361, 454
Lock 34 to lock 28	30. 471	35, 697, 384	16, 673, 184	5, 633, 250	2, 658, 775	24, 965, 209	10, 732, 175
Lock 28 to lock 19	29. 627	33, 865, 160	16, 315, 862	6, 169, 750	2, 586, 925	25, 072, 537	8, 792, 623
Lock 19 to lock 3	12. 162	16, 813, 398	6, 655, 046	6, 035, 625	2, 714, 687	15, 405, 358	1, 407, 940
Lock 3 to lock 1	6. 279	18, 715, 052	3, 549, 686	8, 315, 750	2, 494, 725	14, 360, 161	4, 354, 891
Oneida Lake, Oneida River, and Oswego Canal	61. 067	Abundant	....	....	....	....	....

By reference to the tabular statement, it will be seen that the smaller surpluses of water occur between locks 46 at Utica and 34 east of Little Falls, and lock 19 west of Cohoes and lock 3 at West Troy.

As the proposed canal will be 3 feet deeper than the Erie Canal, the quantity may be increased by widening and deepening the present feeders, or by the construction of one or more of those proposed by Mr. C. A. Olmsted, civil engineer, in his report to the canal commissioners in 1871, and shown on the map of feeders and reservoirs attached to his report, a copy of which is herewith sent.

The quantity of water required for lockage is estimated on the capacity of each lock, and no allowance made for displacement of water by the boat when in the locks; there will be a saving of lockage-water in proportion to the draught of the boat, the heaviest laden boat requiring the smallest amount of water.

Only one-half of the supply of water to the summit-level being used eastward, there remains for the trade westward, and by the Oneida Canal to the lake, 6,443,850 cubic feet per day, after providing for one hundred lockages per day, loss by leakage, evaporation and filtration on the summit-level, and the canal to Oneida Lake, thus showing that an abundant supply may be obtained for the enlarged canal by adding to the present supply the quantity to be obtained from the Fish Creek feeder, which is provided for in this estimate. A map of the country around Fish Creek, showing the location of the feeder, will accompany this report.

Referring again to the report and map of Mr. C. A. Olmsted, civil engineer, it will be seen that additional supplies for the summit-level may be obtained at a moderate outlay, when the increase of trade shall require them.

The Oswego River portion of the route is abundantly supplied, as it receives the water of the Oneida Lake country by the Oneida River, and the water from a long chain of lakes by the Seneca River, which, meeting at three river points, form the Oswego River, and from thence give an abundant supply for the enlarged canal to its junction with Lake Ontario at Oswego.

Respectfully submitted, by your obedient servant,

JAMES S. LAWRENCE,
Assistant Engineer.

Major JOHN M. WILSON,
Corps of Engineers, Bvt. Col. U. S. A.

ONEIDA SHIP-CANAL—CROSS-CUT LINE.

Estimate for section-work from Oswego to Durhamville.

Quantities and items.	Price.	Amount.	Total.
From Oswego lower bridge to lock 18:			
8,338 cubic yards rock-excavation ... per cu. yd.	$2 50	$20,845 00	
			$20,845 00
From lock 18 to lock 17:			
8,200 cubic yards earth-excavation ... per cu. yd.	28	2,296 00	
3,150 cubic yards rock-excavation ... do.	1 00	3,150 00	
4,060 cubic yards old vertical wall ... do.	75	3,045 00	
10,270 cubic yards vertical wall to be built ... do.	5 00	51,350 00	
290 cubic yards removing one pier of Utica-street bridge ... do.	1 00	290 00	
290 cubic yards rebuilding pier of bridge ... do.	8 00	2,320 00	
Altering span of bridge ...		1,000 00	
565 cubic yards masonry, 3-arch culvert ... per cu. yd.	9 00	5,085 00	
			68,536 00
From lock 17 to Oswego dam:			
28,200 cubic yards earth-excavation ... per cu. yd.	28	7,896 00	
5,220 cubic yards old vertical wall ... do.	75	3,915 00	
23,420 cubic yards vertical wall to be built ... do.	5 00	117,100 00	
Weigh-lock to be removed ...		700 00	
560 cubic yards masonry in a 3-arch culvert ... per cu. yd.	9 00	5,040 00	
294 cubic yards masonry in abutments of bridge ... do.	8 00	2,352 00	
140 linear feet bridge superstructure ... per lin. ft.	25 00	3,500 00	
294 cubic yards masonry on bridge-abutments ... per cu. yd.	8 00	2,352 00	
140 linear feet bridge-superstructure ... per lin. ft.	25 00	3,500 00	
			146,355 00
From guard-lock 6 and dam to lock No. 16:			
49,700 cubic yards earth-excavation ... per cu. yd.	28	13,916 00	
11,900 yards rock-excavation ... do.	1 00	11,900 00	
4,000 cubic yards slope-wall ... do.	1 75	7,000 00	
3,430 cubic yards lining ... do.	50	1,715 00	
223 cubic yards culvert masonry ... do.	9 00	2,007 00	
			36,538 00
From lock No. 16 to lock No. 15:			
16,400 cubic yards earth-excavation ... per cu. yd.	28	4,592 00	
19,000 cubic yards rock-excavation ... do.	1 00	19,000 00	
5,000 cubic yards embankment ... do.	28	1,400 00	
3,040 cubic yards slope-wall ... do.	1 75	5,320 00	
2,600 cubic yards lining ... do.	50	1,300 00	
			31,612 00
From lock No. 15 to lock No. 14:			
9,600 cubic yards earth-excavation ... per cu. yd.	28	2,688 00	
8,000 cubic yards rock-excavation ... do.	1 00	8,000 00	
4,160 cubic yards slope-wall ... do.	1 75	7,280 00	
3,570 cubic yards lining ... do.	50	1,785 00	
			19,753 00
From lock No. 14 to lock No. 13:			
76,700 cubic yards earth-excavation ... per cu. yd.	28	21,476 00	
51,500 cubic yards rock-excavation ... do.	1 00	51,500 00	
8,850 cubic yards slope-wall ... do.	1 75	15,487 50	
7,600 cubic yards lining ... do.	50	3,800 00	
			92,263 50
From lock No. 13 to lock No. 12:			
24,400 cubic yards earth-excavation ... per cu. yd.	28	6,832 00	
2,950 cubic yards slope-wall ... do.	1 75	5,162 50	
2,530 cubic yards lining ... do.	50	1,265 00	
			13,259 50
From lock No. 12 to guard-lock 5:			
207,500 cubic yards earth-excavation ... per cu. yd.	28	58,100 00	
152,800 cubic yards rock-excavation ... do.	1 00	152,800 00	
18,840 cubic yards slope-wall ... do.	1 75	32,970 00	
16,160 cubic yards lining ... do.	50	8,080 00	
294 cubic yards masonry in bridge-abutments ... do.	8 00	2,352 00	
140 linear feet bridge-superstructure ... per lin. ft.	25 00	3,500 00	
			257,802 00
From guard-lock 5 to lock 11:			
33,500 cubic yards earth-excavation ... per cu. yd.	28	9,380 00	
14,800 cubic yards rock-excavation ... do.	1 00	14,800 00	
7,080 cubic yards slope-wall ... do.	1 75	12,390 00	
6,070 cubic yards lining ... do.	50	3,035 00	
294 cubic yards bridge-masonry ... do.	8 00	2,352 00	
140 linear feet bridge-superstructure ... per lin. ft.	25 00	3,500 00	
			45,457 00
From lock No. 11 to lock No. 10:			
162,700 cubic yards earth-excavation ... per cu. yd.	28	45,556 00	
11,080 cubic yards slope-wall ... do.	1 75	19,390 00	
9,460 cubic yards lining ... do.	50	4,730 00	
294 cubic yards masonry, C. and R. bridge ... do.	8 00	2,352 00	
140 linear feet bridge-superstructure ... per lin. ft.	25 00	3,500 00	
294 cubic yards masonry, R. bridge ... per cu. yd.	8 00	2,352 00	
140 linear feet bridge-superstructure ... per lin. ft.	25 00	3,500 00	

Estimate for section-work from Oswego to Durhamville—Continued.

Quantities and items.	Price.	Amount.	Total.
From lock No. 11 to lock No. 10—Continued.			
480 cubic yards masonry in aqueduct ....per cu. yd..	$9 00	$4, 320 00	
86,000 feet (b. m.) timber and plank in superstructure per 1,000 ft..	60 00	5, 160 00	
1,100 pounds bolts, spikes, and nails.........:..............per lb..	06	66 00	
			$90, 926 00
From lock No. 10 to lock No. 9:			
7,200 cubic yards earth-excavation ....per cu. yd..	28	2, 016 00	
470 cubic yards slope-wall ....do....	1 75	822 50	
400 cubic yards lining ....do....	50	200 00	
From lock No. 9 to lock No. 8:			
42,300 cubic yards earth-excavation.....................per cu. yd..	28	11, 844 00	
37,100 cubic yards rock-excavation ....do....	1 00	37, 100 00	
10,760 cubic yards vertical wall...............................do....	5 00	53, 800 00	
2,260 cubic yards slope-wall ....do	1 75	3, 955 00	
1,940 cubic yards lining ....do....	50	970 00	
588 cubic yards bridge-masonry ....do	8 00	4, 704 00	
260 linear feet double-track bridge ....per lin. ft..	40 00	10, 400 00	
294 cubic yards bridge-masonry........................per cu. yd..	8 00	2, 352 00	
140 linear feet bridge-superstructure ....per lin. ft..	25 00	3, 500 00	
			128, 625 00
From lock No. 8 to guard-lock No. 3:			
47,600 cubic yards earth-excavation ....per cu. yd..	28	13, 328 00	
28,950 cubic yards rock-excavation ....do....	1 00	28, 950 00	
3,890 cubic yards slope-wall ....do....	1 75	6, 807 50	
3,340 cubic yards lining ....:.........do....	50	1, 670 00	
294 cubic yards bridge-masonry ....do	8 00	2, 352 00	
140 linear feet bridge-superstructure....................per lin. ft..	25 00	3, 500 00	
			56, 607 50
From guard-lock No. 3 to lift-lock 7:			
126,800 cubic yards earth-excavation...................per cu. yd..	28	35, 504 00	
15,020 cubic yards slope-wall....................................do....	1 75	26, 285 00	
12,900 cubic yards lining ....do....	50	6, 450 00	
			68, 239 00
From lock No. 7 to lock No. 6:			
341,000 cubic yards earth-excavation...................per cu. yd..	28	95, 480 00	
29,000 cubic yards rock-excavation ....do....	1 00	29, 000 00	
19,030 cubic yards slope-wall ....do....	1 75	33, 302 50	
16,300 cubic yards lining ....do....	50	8, 150 00	
			165, 932 50
From lock No. 6 to Brandy Brook culvert:			
378,700 cubic yards earth-excavation ....per cu. yd..	28	106, 036 00	
38,000 cubic yards rock-excavation ....do....	1 00	38, 000 00	
22,500 cubic yards slope-wall ....do....	1 75	39, 375 00	
19,300 cubic yards lining ....do....	50	9, 650 00	
			193, 061 00
Changing spans of two road-bridges..................................			2, 000 00
			1, 440, 850 50

From lower bridge, Oswego, to Brandy Brook culvert, at Phœnix, 20.5 miles.

Quantities and items.	Price.	Amount.	Total.
8,338 cubic yards rock-excavation ....per cu. yd	$2 50	$20,845 00	
394,200 cubic yards rock-excavation ....do....	1 00	394,200 00	
1,560,500 cubic yards earth-excavation...........................do....	28	436,940 00	
5,000 cubic yards embankment ....do....	28	1,400 00	
9,280 cubic yards old vertical wall to be removed..............do....	75	6,960 00	
44,450 cubic yards vertical wall to be built ....do....	5 00	222,250 00	
123,170 cubic yards slope-wall ....do....	1 75	215,547 50	
105,600 cubic yards lining for slope-wall ....do....	50	52,800 00	
2,940 cubic yards masonry in canal-bridges ....do....	8 00	23,520 00	
1,120 linear feet superstructure in canal-bridges ....per lin. ft	25 00	28,000 00	
260 linear feet superstructure in canal-bridges..................do....	40 00	10,400 00	
1,348 cubic yards masonry in culverts....................per cu. yd	9 00	12,132 00	
290 cubic yards masonry in river-bridge to be removed ....do....	1 00	290 00	
290 cubic yards masonry in river-bridge to be built.............do....	8 00	2,320 00	
3 spans of bridges to be changed.......................per span	1,000 00	3,000 00	
Aqueduct-enlargement...	....	9,546 00	
Removing weigh-lock..	....	700 00	
			$1,440,850 50
Lift-lock No. 18		80,551 00	
Lift-lock No. 17		76,605 00	
Guard-lock No. 6...		56,558 00	
Lift-lock No. 16		67,888 00	
Lift-lock No. 15		76,015 00	
Lift-lock No. 14		71,411 00	
Lift-lock No. 13		78,876 00	
Lift-lock No. 12		77,865 00	
Guard-lock No. 5...		56,505 00	
Lift-lock No. 11		84,657 00	
Lift-lock No. 10		65,493 00	
Lift-lock No. 9		64,695 00	
Lift-lock No. 8		78,527 00	
Guard-lock No. 3...		52,808 00	
Lift-lock No. 7		56,646 00	
Guard-lock No. 2...		58,087 00	
Lift-lock No. 6		59,772 00	
Guard-lock No. 1...		50,927 00	
			1,211,886 00
			2,652,736 50

Estimate for cross-cut line, Oneida River to Brewerton.

Distance in feet.	Quantities and items.	Price.	Amount.	Total.
14,586	From Brandy Brook culvert to Oneida River, (point B:)			
	1,508,000 cubic yards earth-excavation ....per cub. yd.	$0 28	$422,240	
	300,500 cubic yards rock-excavation ....do ...	1 00	300,500	
42,268	From Peter Scott's swamp (point B) along the Oneida River to (point A):			
	424,000 cubic yards earth-excavation......per cub. yd	25	106,000	
11,220	From mouth of Black Creek (point A) cross-cut to intersection of Oneida River, near Brewerton:			
	1,010,000 cubic yards earth-excavation ....per cub. yd	28	282,800	
	161,800 cubic yards rock-excavation.............do	1 00	161,800	
6,618	From intersection of cross-cut along the Oneida River to Brewerton bridge:			
	83,400 cubic yards earth-excavation.......per cub. yd	25	20,850	
				$1,294,190
74,692	Equal to 14.146 miles.			
4,070	From Brewerton bridge to 10 feet water in Oneida Lake:			
	73,300 cubic yards earth-excavation ....per cub. yd	25	18,325	
105,600	From the 10-foot water-line at the west end to the 10-foot water-line at the east end of Oneida Lake.			
3,000	From the 10-foot water-line at the east end of the lake to lock No. 6 of the Oneida Canal:			
	36,800 cubic yards earth-excavation.......per cub. yd.	25	9,200	
	5,470 linear feet of pier.......................per lin. ft	10 00	54,700	
	40 linear feet of pier...............................do....	20 00	800	
				83,025
112,670	Equal to 21.339 miles.			
26,835	From lock No. 6, Oneida Canal, to the junction with the Erie Canal at Durhamville (equal to 5.082 miles):			
	738,000 cubic yards earth-excavation......per cub. yd	28	206,640	
				206,640
139,505	Equal to 26.421 miles.			
	Carried forward..................................	....	....	1,583,855

From Brandy Brook culvert, at Phœnix, by the cross-cut line to Oneida Lake, and thence by Oneida Canal to Durhamville.

Distance in feet.	Quantities and items.	Price.	Amount.	Total.
	Brought forward			$1,583,855
	From Brandy Brook culvert to Oneida River, at Peter Scott's swamp:			
	22,688 cubic yards slope-wall ... per cub. yd.	$1 75	$39,704	
	19,448 cubic yards lining ... do	50	9,724	
	On cross-cut line from the mouth of Black Creek to the intersection of Oneida River, near Brewerton:			
	17,456 cubic yards slope-wall ... per cub. yd.	1 75	30,548	
	14,960 cubic yards lining ... do	50	7,480	
				87,456
26,835	On Oneida Canal:			
	39,300 cubic yards slope-wall ... per cub. yd.	1 75	68,775	
	33,688 cubic yards lining ... do	50	16,844	
	7,018 cubic yards graveling tow-path ... do	50	3,509	
				89,128
	1,844 cubic yards arch culvert masonry ... per cub. yd.	9 00	16,596	
	3,234 cubic yards bridge ... do	8 00	25,872	
	1,540 linear feet, 11 bridges ... do	25 00	38,500	
				80,968
26,835	Equal to 5.082 miles.			
	Carried forward			1,841,407

From Brandy Brook culvert, at Phœnix, by the cross-cut line to the Oneida River, and thence to Brewerton; thence by Oneida Lake and the Oneida Canal to Durhamville.

Locks.	Amount.	Total.
Brought forward		$1,841,407
Lift-lock No. 1, Oneida River	$58,492	
Lift-lock No. 2, Oneida River	65,070	
		123,562
Lift-lock No. 6, Oneida Canal	84,367	
Lift-lock No. 5, Oneida Canal	63,322	
Lift-lock No. 4, Oneida Canal	62,507	
Lift-lock No. 3, Oneida Canal	61,831	
Lift-lock No. 2, Oneida Canal	61,936	
Lift-lock No. 1, Oneida Canal	72,200	
		406,163
Total		2,371,132

SPECIMEN METHOD OF ESTIMATING COST OF LOCKS.

Estimate of lock No. 16, *Oswego Canal,* 8.666 *feet lift.*

Quantities and items.	Price.	Amount.	Total.
Bailing and draining		$4,000	
7,000 cubic yards earth-excavation ... per cub. yd	$0 28	1,960	
3,400 cubic yards rock-excavation, requiring blasting ... do	1 00	3,400	
900 cubic yards embankment ... do	28	252	
300 cubic yards lining and graveling ... do	50	150	
200 cubic yards puddling ... do	30	60	
100 cubic yards slope-wall and paving ... do	2 00	200	
180 cubic yards loose stone ... do	1 50	270	
160 cubic yards vertical wall in cement ... do	6 00	960	
90 cubic yards vertical wall, dry ... do	3 00	270	
3,172 cubic yards masonry in lock-walls ... do	13 00	41,236	
330 cubic yards masonry in culverts ... do	9 00	2,970	
300 cubic yards concrete-masonry ... do	5 00	1,500	
100 cubic yards quarried-stone pavement ... do	2 00	200	
45,000 feet, board-measure, white-oak timber and plank ... per 1,000 ft.	60 00	2,700	
24,400 feet, board-measure, white-pine timber ... do	45 00	1,098	
205,000 feet, board-measure, hemlock timber ... do	20 00	4,100	
11,800 pounds wrought iron ... per pound.	12	1,416	
8,500 pounds cast iron ... do	08	680	
4,100 pounds spikes and nails ... do	06	246	
600 pounds lead ... do	12	72	
8 snubbing-posts ... each	6 00	48	
Painting		50	
Sulphur and sand cement		50	
			$67,888

ONEIDA SHIP-CANAL—SUMMARY OF CROSS-CUT LINE.

From Oswego to Durhamville by way of the cross cut line from Phœnix to the Oneida River, and through the Oneida Lake and Oneida Canal to the Erie Canal at Durhamville.

Distance in miles.			Amount.
20.500	Estimated cost from Oswego to Phœnix	Excavation	$2,652,736 50
14.146	Estimated cost from Phœnix to Brewerton	do	1,294,190 00
21.339	Estimated cost from Brewerton through the Oneida Lake to the Oneida Canal.	Excavation and piers	83,025 00
5.082	Oneida Lake Canal	Excavation	206,640 00
	Cross-cut lines, Oneida River	Slope-wall	87,456 00
	Oneida Canal	do	89,128 00
	do	Culverts and bridges	80,968 00
	Oneida River	Locks	123,562 00
	Oneida Canal	do	406,163 00
			5,023,868 50
	Add 10 per cent. for engineering and contingencies.		502,386 85
	Land-damages		397,341 50
			5,923,596 85

ONEIDA SHIP-CANAL—ONEIDA RIVER LINE.

From lower bridge, Oswego, to Brandy Brook culvert at Phœnix, 20.5 *miles.*

Quantities and items.	Price.	Amount.	Total.
8,338 cubic yards rock-excavation per cu. yd.	$2 50	$20,845 00	
394,200 cubic yards rock-excavation do	1 00	394,200 00	
1,560,500 cubic yards earth-excavation do	28	436,940 00	
5,000 cubic yards embankment do	28	1,400 00	
9,280 cubic yards old vertical wall to be removed do	75	6,960 00	
44,450 cubic yards of vertical wall to be built do	5 00	222,250 00	
123,170 cubic yards slope-wall do	1 75	215,547 50	
105,600 cubic yards lining for slope-wall do	50	52,800 00	
2,940 cubic yards masonry in canal-bridges do	8 00	23,520 00	
1,120 linear feet superstructure in bridges per lin. ft.	25 00	28,000 00	
260 linear feet superstructure in bridges do	40 00	10,400 00	
1,348 cubic yards masonry in culverts per cu. yd.	9 00	12,132 00	
290 cubic yards masonry in bridges to be removed do	1 00	290 00	
290 cubic yards masonry in river-bridges to be built do	8 00	2,320 00	
3 spans of river-bridges to be changed each	1,000 00	3,000 00	
Aqueduct enlargement		9,546 00	
Removing weigh-lock		700 00	
			$1,440,850 50
Lift-lock No. 18		80,551 00	
Lift-lock No. 17		76,605 00	
Guard-lock No. 6		56,558 00	
Lift-lock No. 16		67,898 00	
Lift-lock No. 15		76,015 00	
Lift-lock No. 14		71,411 00	
Lift-lock No. 13		78,876 00	
Lift-lock No. 12		77,865 00	
Guard-lock No. 5		56,503 00	
Lift-lock No. 11		84,657 00	
Lift-lock No. 10		65,493 00	
Lift-lock No. 9		62,695 00	
Lift-lock No. 8		78,527 00	
Guard-lock No. 3		52,808 00	
Lift-lock No. 7		56,646 00	
Guard-lock No. 2		58,087 00	
Lift-lock No. 6		59,772 00	
Guard-lock No. 1		50,927 00	
			1,211,886 00
Carried forward			2,652,736 50

River line from Brandy Brook culvert to Brewerton bridge, Oneida Lake.

Distance in feet.	Quantities and items.	Price.	Amount.	Total.
	Brought forward			$2, 652, 736 50
	From Brandy Brook culvert to Three Rivers Point:			
	237,600 cubic yards earth-excavation..per cu. yd.	$0 28	$66, 528 00	
	29,000 cubic yards rock-excavation.........do	1 00	29, 000 00	
	5,660 cubic yards vertical wall............do	5 00	28, 300 00	
	13,532 cubic yards slope-wall..............do	1 75	23, 681 00	
	11,594 cubic yards lining..................do	50	5, 797 00	
Brandy Brook....	971 cubic yards culvert-masonry..........do	9 00	8, 739 00	
	294 cubic yards bridge-masonry...........do	8 00	2, 352 00	
	140 linear feet bridge-superstructure..per lin. ft.	25 00	3, 500 00	
Guard-lock 1 to 6.	971 cubic yards culvert-masonry......per cu. yd.	9 00	8, 739 00	
Guard-lock 1 to Change-bridge.	240 cubic yards bridge-masonry...........do	8 00	1, 920 00	
	140 linear feet bridge-superstructure..per lin. ft.	20 00	2, 800 00	
Three Rivers	1 swing-bridge		12, 596 00	
				193, 592 00
From Brandy Brook culvert to Three Rivers, 15,367 feet.	From Three Rivers Point along the Oneida River, to Brewerton bridge at Oneida Lake:			
18,300 feet........	137,400 cubic yards earth-excavation..per cu. yd	25	34, 350 00	
42,968 feet........	424,000 cubic yards earth-excavation......do	25	106, 000 00	
31,675 feet........	192,800 cubic yards earth-excavation......do	25	48, 200 00	
6,618 feet.........	83,400 cubic yards earth-excavation.......do	25	20, 850 00	
	No. 1 guard-lock at Phœnix		50, 927 00	
Caughdenoy	766 cubic yards swing-bridge masonry, per cu. yd.	8 00	6, 128 00	
	Superstructure-iron		8, 000 00	
Brewerton 114,228 equal to 21.634 miles.	Swing-bridge		12, 596 00	
				287, 051 00
	Graveling towing-paths from Brandy Brook culvert to Three Rivers Point		2, 134 00	
	Lift-lock No. 1, Oneida River		58, 492 00	
	Lift-lock No. 2, Oneida River		65, 070 00	
				125, 696 00
	Carried forward			3, 259, 435 50

Oneida River line, from Three Rivers Point along the Oneida River, through the Oneida Lake and Canal, to the Erie Canal at Durhamville.

Distance in feet.	Quantities and items.	Price.	Amount.	Total.
	Brought forward			$3, 259, 435 5
4, 070	Brewerton bridge to 10-foot water line, Oneida Lake:			
	73,300 cubic yards earth-excavation..........per cu. yd.	$0 25	$18, 325	
				18, 325 00
105, 600	From the 10-foot water-line of the west end of the lake to the 10-foot water-line at the east end.			
3, 000	From the 10-foot water-line at the east end of Oneida Lake to lock No. 6 of the Oneida Canal:			
	5,470 linear feet of pier.......................per lin. ft.	10 00	54, 700	
	40 linear feet of pier..............................do	20 00	800	
	36 800 cubic yards earth-excavation ....per cu. yd.	25	9, 200	
				64, 700 00
26, 835	From lock No. 6, Oneida Canal, to junction with the Erie Canal at Durhamville:			
	738,000 cubic yards earth-excavation........per cu. yd.	25	184, 500	
	39,300 cubic yards slope-wall......................do	1 75	68, 775	
	32,688 cubic yards lining..........................do	50	16, 344	
				269, 619 00
	Road and change bridges:			
	3,234 cubic yards bridge-masonry...............do	8 00	25, 872	
	1,844 cubic yards culvert-masonry ....do	9 00	16, 596	
	1,540 linear feet (11) bridges ....per lin. ft	25 00	38, 500	
				80, 968 00
	Lift-lock No. 6, Oneida Canal		84, 367	
	Lift-lock No. 5, Oneida Canal		63, 322	
	Lift-lock No. 4, Oneida Canal		62, 507	
	Lift-lock No. 3, Oneida Canal		61, 831	
	Lift-lock No. 2, Oneida Canal		61, 936	
	Lift-lock No. 1, Oneida Canal		72, 200	
				406, 163 00
	Total			4, 099, 210 50

SPECIMEN OF METHOD OF ESTIMATING COST OF LOCKS, ONEIDA SHIP-CANAL, ONEIDA RIVER LINE.

Estimate of lock No. 16, Oswego Canal, 8,666 feet lift.

Quantities and items.	Price.	Amount.	Total.
Bailing and draining		$4,000	
7,000 cubic yards earth-excavation per cu. yd.	$0 28	1,960	
3,400 cubic yards rock-excavation, requiring blasting do	1 00	3,400	
900 cubic yards embankment do	28	252	
300 cubic yards lining and graveling do	50	150	
200 cubic yards puddling do	30	60	
100 cubic yards slope-wall and paving do	2 00	200	
180 cubic yards loose stone do	1 50	270	
160 cubic yards vertical wall, in cement do	6 00	960	
90 cubic yards vertical wall, dry do	3 00	270	
3,172 cubic yards masonry in lock-walls do	13 00	41,236	
330 cubic yards masonry in culverts do	9 00	2,970	
300 cubic yards concrete-masonry do	5 00	1,500	
100 cubic yards quarried-stone pavement do	2 00	200	
45,000 feet, b. m., white-oak timber and plank per M ft.	60 00	2,700	
24,400 feet, b. m., white-pine timber do	45 00	1,098	
205,000 feet, b. m., hemlock timber do	20 00	4,100	
11,800 pounds wrought-iron per lb.	12	1,416	
8,500 pounds cast-iron do	08	680	
4,100 pounds spikes and nails do	06	246	
600 pounds lead do	12	72	
8 snubbing-posts each	6 00	48	
Painting		50	
Sulphur and sand cement		50	
			$67,888.00

ONEIDA SHIP-CANAL—ONEIDA RIVER LINE.

From Oswego to the Three Rivers Point, thence along the Oneida River to Brewerton, thence through Oneida Lake and the Oneida Canal to the Erie Canal at Durhamville.

Distance in miles.	Items.	Amount.	Total.
20.500	Oswego to Phœnix (Brandy Brook)	$2,652,736 50	
21.634	Phœnix to Three Rivers Point, thence along the Oneida River to Brewerton	606,699 00	
21.339	Through the Oneida Lake to the Oneida Canal	839,775 00	
5.082	Thence along the canal to Durhamville		
			$4,099,210 50
68.555	Add 10 per cent. for engineering and contingencies	409,921 05	
	Land-damages	452,320 50	
			862,241 55
	Total		4,961,452 05

ONEIDA SHIP-CANAL.

Estimated cost of section from Durhamville Station to Rome Station, 860.

Quantities and items.	Price.	Amount.	Total.
2,580,000 cubic yards earth-excavation per cu. yd.	$0 28	$722,400	
103,700 cubic yards puddling do	30	31,110	
20,800 cubic yards vertical wall do	5 00	104,000	
122,260 cubic yards slope-wall do	1 75	213,955	
104,800 cubic yards lining do	50	52,400	
24,000 cubic yards graveling, tow-path do	50	12,000	
			$1,137,865 00
Oneida Creek, aqueduct:			
1,591 cubic yards of masonry per cu. yd.	9 00	14,319	
20,750 feet, b. m., oak timber per 1,000 ft.	60 00	1,245	
18,000 feet, b. m., pine do	45 00	810	
30,000 feet, b. m., hemlock do	20 00	600	
800 pounds spikes and nails per lb.	06	48	
			17,022 00
330 cubic yards masonry, arch-culvert per cu. yd.	9 00	2,970	
16,500 feet, b. m., hemlock per 1,000 ft.	20 00	330	
150 pounds iron spikes and nails per lb.	06	9	
			3,309 00

Estimated cost of section from Durhamville Station to Rome Station, 860—Continued.

Quantities and items.	Price.	Amount.	Total.
Oneida Creek aqueduct—Continued.			
370 cubic yards masonry in arch-culvert............per cu. yd..	$9 00	$3,330	
29,500 feet, b. m., hemlock ....per 1,000 ft..	20 00	590	
300 pounds spikes and nails ....per lb..	06	18	
			$3,938 00
370 cubic yards masonry in arch-culvert ....per cu. yd..	9 00	3,330	
29,500 feet, b. m., hemlock ....per 1,000 ft..	20 00	590	
300 pounds spikes and nails..............................per lb..	06	18	
			3,938 00
296 cubic yards masonry in arch-culvert............per cu. yd..	9 00	2,664	
32,500 feet, b. m., hemlock ....per 1,000 ft..	20 00	650	
350 pounds spikes and nails ....per lb..	06	21	
			3,335 00
296 cubic yards masonry in arch-culvert............per cu. yd..	9 00	2,664	
32,500 feet, b. m., hemlock ....per 1,000 ft..	20 00	650	
350 pounds spikes and nails..............................per lb..	06	21	
			3,335 00
296 cubic yards masonry in arch-culvert ....per cu. yd..	9 00	2,664	
32,500 feet, b. m., hemlock ....per 1,000 ft..	20 00	650	
350 pounds spikes and nails..............................per lb..	06	21	
			3,335 00
296 cubic yards masonry in arch-culvert ....per cu. yd..	9 00	2,664	
32,500 feet, b. m., hemlock..........................per 1,000 ft..	20 00	650	
350 pounds spikes and nails..............................per lb..	06	21	
			3,335 00
105 cubic yards masonry in arch-culvert ....per cu. yd..	9 00	945	
13,500 feet, b. m , hemlock..........................per 1,000 ft..	20 00	270	
100 pounds spikes and nails..............................per lb..	06	6	
			1,221 00
225 cubic yards masonry in arch-culvert ....per cu. yd..	9 00	2,025	
22,500 feet, b. m., hemlock..........................per 1,000 ft..	20 00	450	
300 pounds spikes and nails..............................per lb..	06	18	
			2,493 00
225 cubic yards masonry in arch-culvert............per cu. yd..	9 00	2,025	
22,500 feet, b. m., hemlock ....per 1,000 ft..	20 00	450	
300 pounds spikes and nails..............................per lb..	06	18	
			2,493 00
304 cubic yards masonry in arch-culvert............per cu. yd..	9 00	2,736	
16,500 feet, b. m , hemlock..........................per 1,000 ft..	20 00	330	
200 pounds spikes and nails..............................per lb..	06	12	
			3,078 00
95 cubic yards masonry in arch-culvert.............per cu. yd..	9 00	855	
7,000 feet, b. m., hemlock ....per 1,000 ft..	20 00	140	
100 pounds spikes and nails..............................per lb..	06	6	
			1,001 00
274 cubic yards masonry in arch-culvert............per cu. yd..	9 00	2,466	
14,500 feet, b. m., hemlock..........................per 1,000 ft..	20 00	290	
200 pounds spikes and nails ....per lb..	06	12	
			2,768 00
122 cubic yards masonry in arch-culvert............per cu. yd..	4 00	488	
13,200 feet, b. m., hemlock ....per 1,000 ft..	20 00	264	
150 pounds spikes and nails ....per lb..	06	9	
			761 00
200 cubic yards masonry in arch-culvert............per cu. yd..	4 00	800	
15,750 feet, b. m., hemlock..........................per 1,000 ft..	20 00	315	
200 pounds spikes and nails..............................per lb..	06	12	
			1,127 00
225 cubic yards masonry in arch-culvert ....per cu. yd..	9 00	2,025	
22,500 feet, b. m., hemlock ....per 1,000 ft..	20 00	450	
300 pounds iron spikes and nails..........................per lb..	06	18	
			2,493 00
448 cubic yards of masonry in waste-weir...........per cu. yd..	9 00	4,032	
9,000 feet, b. m., oak timber, &c........................per 1,000 ft..	60 00	540	
6,600 feet, b. m., pine timber, &c ....do.....	45 00	297	
19,600 feet, b. m., hemlock ....do.....	20 00	392	
1,800 pounds iron spikes and nails........................per lb..	06	108	
			5,369 00
5,770 cubic yards masonry, bridge-abutments.......per cu. yd..	8 00	46,232	
2,793 linear feet bridge-superstructure ....per lin. ft..	25 00	69,825	
280 linear feet bridge-superstructure...............do.....	40 00	11,200	
140 linear feet, 1 railroad bridge..........................do.....	88 00	12,320	
Do...do.....	65 00	9,100	
Do...do.....	48 00	6,720	
Do...do.....	54 00	7,560	
Do...do.....	25 00	3,500	
Do...do.....	28 00	3,920	
			170,377 00
Carried forward..	....	....	1,370,593 00

Estimated cost of section from Rome, station 860, *to Utica, station* 1660.

Quantities and items.	Price.	Amount.	Total.
Brought forward	....	....	$1,370,593 00
2,384,800 cubic yards earth-excavation .... per cu. yd	$0 28	$667,774 00	
96,000 cubic yards puddling .... do....	30	28,800 00	
29,032 cubic yards vertical wall .... do....	5 00	145,160 00	
99,020 cubic yards lining .... do....	50	49,510 00	
109,900 cubic yards slope-wall .... do....	1 75	192,325 00	
22,222 cubic yards graveling, tow-path .... do....	50	11,111 00	
			1,094,650 00
Oriskany aqueduct.			
376 cubic yards masonry in foundation and backing .... per cu. yd	4 00	1,504 00	
791 cubic yards masonry, arches and face-work .... do....	9 00	7,119 00	
15 cubic yards masonry, coping .... do....	13 00	195 00	
229,000 feet, board-measure, oak timber and plank .... per 1,000 ft	60 00	13,740 00	
36,000 feet, board-measure, pine .... do....	45 00	1,620 00	
20,800 feet, board-measure, hemlock .... do....	20 00	516 00	
20,950 pounds iron ties, bolts, and spikes .... per lb	06	1,257 00	
			25,851 00
Saquoit aqueduct.			
280 cubic yards masonry, foundation and backing .... per cu. yd	4 00	1,120 00	
416 cubic yards masonry, arches and face-work .... do....	9 00	3,744 00	
11 cubic yards masonry, coping .... do....	13 00	143 00	
157,750 feet, board-measure, oak timber .... per 1,000 ft	60 00	9,465 00	
24,800 feet, board-measure, pine .... do....	45 00	1,116 00	
14,750 feet, board-measure, hemlock .... do....	20 00	295 00	
14,500 pounds iron .... per lb	06	870 00	
			16,753 00
310 cubic yards arch-culvert masonry .... per cu. yd	9 00	2,790 00	
16,500 feet, board-measure, hemlock timber, &c .... per 1,000 ft	20 00	330 00	
100 pounds iron .... per lb	06	6 00	
			3,126 00
367 cubic yards double arch-culvert masonry .... per cu. yd	9 00	3,303 00	
22,500 feet, board-measure, hemlock timber, &c .... per 1,000 ft	20 00	450 00	
100 pounds iron .... per lb	06	6 00	
			3,759 00
730 cubic yards box-culvert masonry .... per cu. yd	4 00	2,920 00	
13,200 feet, board-measure, hemlock timber, &c .... per 1,000 ft	20 00	264 00	
100 pounds iron .... per lb	06	6 00	
			3,190 00
448 cubic yards waste-weir masonry .... per cu. yd	9 00	4,032 00	
25,000 feet, board-measure, hemlock timber, &c .... per 1,000 ft	20 00	500 00	
10,000 feet, board-measure, pine .... do....	45 00	450 00	
1,800 pounds iron .... per lb	06	108 00	
			5,090 00
6,720 cubic yards bridge-masonry .... per cu. yd	8 00	53,760 00	
1,960 linear feet, 14 road-bridges .... per lin. ft	25 00	49,000 00	
1,540 linear feet, 11 road-bridges .... do....	38 00	58,520 00	
140 linear feet, 1 road-bridge .... do....	60 00	8,400 00	
140 linear feet, 1 road-bridge .... do....	64 00	8,960 00	
140 linear feet, 1 road-bridge .... do....	107 00	14,980 00	
280 linear feet, 2 railroad swing-bridges .... do....	85 00	23,800 00	
			217,420 00
Removing weigh-lock at Utica	......	700 00	
			700 00
Carried forward	......	....	2,741,132 00

Estimated cost of section from Utica, station 1660, *to Ilion, station* 2260.

Quantities and items.	Price.	Amount.	Total.
Brought forward	....	....	$2,741,132 00
1,815,500 cubic yards earth-excavation .... per cu. yd.	$0 28	$508,284 00	
73,100 cubic yards puddling .... do....	30	21,930 00	
18,294 cubic yards vertical wall .... do....	5 00	91,470 00	
82,008 cubic feet slope-wall .... do....	1 75	143,514 00	
74,390 cubic yards lining .... do....	50	37,195 00	
16,666 cubic yards graveling, tow-path .... do....	50	8,333 00	
			810,726 00
Furgerson's aqueduct.			
109 cubic yards masonry, in foundation and backing .... per cu. yd.	4 00	436 00	
153 cubic yards masonry, arch and face work .... do....	9 00	1,377 00	
8 cubic yards masonry, coping .... do....	13 00	104 00	
56,300 feet, board-measure, oak .... per 1,000 ft.	60 00	3,378 00	
9,000 feet, board-measure, pine .... do....	45 00	405 00	
6,750 feet, board-measure, hemlock .... do....	20 00	135 00	
5,200 pounds iron bolts and spikes .... per lb.	06	312 00	
			6,147 00

Estimated cost of section from Utica, station 1660, to Ilion, station 2260.

Quantities and items.	Price.	Amount.	Total.
Frankfort aqueduct.			
204 cubic yards masonry, in foundation and backing.....per cu. yd	$4 00	$816 00	
362 cubic yards masonry, arches and face-work................do....	9 00	3,258 00	
8 cubic yards masonry, coping.....................................do...	13 00	104 00	
108,000 feet, board-measure, oak ....per 1,000 ft	60 00	6,480 00	
17,000 feet, board-measure, pine ....do...	45 00	765 00	
9,500 feet, board-measure, hemlock ....do ..	20 00	190 00	
9,900 pounds iron bolts and spikes ....per lb	06	594 00	
			$12,207 00
Ilion aqueduct.			
131 cubic yards masonry, foundation and backing ....per cu. yd.	4 00	524 00	
245 cubic yards masonry, arches and face-work ....do....	9 00	2,205 00	
10 cubic yards masonry, coping ....do....	13 00	130 00	
109 000 feet, board-measure, oak ....per 1,000 ft	60 00	6,540 00	
17,000 feet, board-measure, pine ....do...	45 00	765 00	
9,500 feet, board-measure, hemlock ....do...	20 00	190 00	
9,950 pounds iron bolts and spikes ....per lb.	06	597 00	
			10,951 00
95 cubic yards masonry, arch-culvert ....per cu. yd	9 00	855 00	
7,000 feet, board-measure, hemlock ....per 1,000 ft	20 00	140 00	
50 pounds spikes ....per lb.	06	3 00	
			998 00
225 cubic yards masonry in arch-culvert...................per cu. yd	9 00	2,025 00	
22.750 feet, board-measure, hemlock ....per 1,000 ft	20 00	455 00	
100 pounds spikes ....per lb	06	6 00	
			2,486 00
25 cubic yards masonry in arch-culvert . ...per cu. yd	9 00	675 00	
7,500 feet, board-measure, hemlock.........................per 1,000 ft	20 00	150 00	
50 pounds spikes ....per lb	06	3 00	
			828 00
295 cubic yards masonry in arch-culvert...................per cu. yd	9 00	2,655 00	
16 000 feet, board-measure, hemlock ....per 1,000 ft.	20 00	320 00	
50 pounds spikes...per lb	06	3 00	
			2,978 00
225 cubic yards masonry in arch-culvert...................per cu. yd	9 00	2,025 00	
22,750 feet, board-measure, hemlock ....per 1,000 ft	20 00	455 00	
100 pounds spikes ....per lb	06	6 00	
			2,486 00
122 cubic yards masonry in box-culvert ....per cu. yd.	4 00	488 00	
13,250 feet, board-measure, hemlock ....per 1,000 ft	20 00	265 00	
100 pounds spikes and nails..per lb	06	6 00	
			759 00
122 cubic yards masonry in box-culvert....................per cu. yd	4 00	488 00	
13,250 feet, board-measure, hemlock ....per 1,000 ft	20 00	265 00	
100 pounds spikes and nails.. per lb	06	6 00	
			759 00
122 cubic yards masonry in box-culvert....................per cu. yd	4 00	488 00	
13,250 feet, board-measure, hemlock ....per 1,000 ft	20 00	265 00	
100 pounds spikes and nails ....per lb	06	6 00	
			759 00
4,298 cubic yards masonry in bridge-abutments ....per cu. yd	8 00	34,384 00	
2,380 linear feet, 17 road-bridges..........................per lin. ft	25 00	59,500 00	
940 linear feet, 7 road-bridges ....do...	40 00	37,600 00	
			131,484 00
Carried forward	....	....	3,724,700 00

Estimated cost of section from Ilion, station 2260, to Little Falls, station 6.

Quantities and items.	Price.	Amount.	Total.
Brought forward	....	....	$3,724,700 00
1,463,850 cubic yards earth-excavation ....per cu. yd.	$0 28	$409,878 00	
33,000 cubic yards rock-excavation ....do...	1 00	33,000 00	
59,400 cubic yards puddling ....do....	30	17,820 00	
2,714 cubic yards vertical wall....................................do....	5 00	13,570 00	
73,856 cubic yards slope-wall ....do....	1 75	129,248 00	
63 916 cubic yards lining ....do....	50	31,958 00	
14,364 cubic yards graveling, tow-path ....do....	50	7,182 00	
			642,656 00
Fulmer Creek aqueduct.			
213 cubic yards masonry..per cu. yd.	4 00	852 00	
341 cubic yards masonry ....do....	9 00	3,069 00	
11 cubic yards coping ....do....	13 00	143 00	
169,000 feet board-measure, oak ....per 1,000 ft	60 00	10,140 00	
26,600 feet, board-measure, pine ....do....	45 00	1,197 00	

Estimated cost of section from Ilion, &c.—Continued.

Quantities and items.	Price.	Amount.	Total.
14,750 feet, board-measure, hemlock........per 1,000 ft	$20 00	$295 00	
15,500 pounds bolts and spikes........per lb	06	930 00	
			$16,626 00
194 cubic yards masonry in double culvert........per cu. yd	9 00	1,746 00	
14,400 feet, board-measure, hemlock........per 1,000 ft	20 00	288 00	
200 pounds spikes and nails........per lb	06	12 00	
			2,046 00
435 cubic yards masonry in box-culverts........per cu. yd.	4 00	1,740 00	
13,500 feet, board-measure, hemlock........per 1,000 ft	20 00	270 00	
200 pounds spikes and nails........per lb	06	12 00	
			2,022 00
391 cubic yards masonry waste-weir........per cu. yd	9 00	3,519 00	
10,000 feet, board-measure, oak........per 1,000 ft	60 00	600 00	
6,600 feet, board-measure, pine........do...	45 00	297 00	
14,000 feet, board-measure, hemlock........do...	20 00	280 00	
1,500 pounds spikes and nails........per lb	06	90 00	
			4,786 00
1,984 cubic yards masonry, bridge-abutments........per cu. yd	8 00	15,872 00	
1,680 linear feet, 12 road bridges........per ft	25 00	42,000 00	
140 linear feet, 1 road-bridge........do...	38 00	5,320 00	
			63,192 00
Carried forward........	....	....	4,456,028 00

Estimated cost of section from Little Falls, station 6, *to Fort Plain, station* 840.

Quantities and items.	Price.	Amount.	Total.
Brought forward........	....	....	$4,456,028 00
1,912,400 cubic yards earth-excavation........per cu. yd	$0 28	$535,472 00	
311,951 cubic yards rock-excavation........do....	1 00	311,951 00	
94,700 cubic yards puddling........do...	30	28,410 00	
5,200 cubic yards vertical wall........do....	5 00	26,000 00	
123,336 cubic yards slope-wall........do....	1 75	215,838 00	
105,718 cubic yards lining........do....	50	52,859 00	
23,166 cubic yards graveling, tow-path........do....	50	11,583 00	
			1,182,113 00
Castle Creek aqueduct.			
326 cubic yards masonry, backing and foundation........per cu. yd	4 00	1,304 00	
1,035 cubic yards masonry, face-work and arches........do...	9 00	9,315 00	
12 cubic yards masonry, coping........do....	13 00	156 00	
22,650 feet, board-measure, hemlock........per 1,000 ft	20 00	453 00	
217,800 feet, board-measure, oak........do....	60 00	13,068 00	
34,200 feet, board-measure, pine........do...	45 00	1,539 00	
19,950 pounds iron........per lb	06	1,197 00	
			27,032 00
Small waste-weir.			
12 cubic yards masonry........per cu. yd	6 00	72 00	
2,000 feet, board-measure, pine........per 1,000 ft	45 00	90 00	
50 pounds iron spikes and nails........per lb	06	3 00	
			165 00
Towing-path bridge.			
2,000 feet, board-measure, pine........per 1,000 ft	45 00	90 00	
100 pounds iron spikes and nails........per lb	06	6 00	
			96 00
Bridges.			
3,087 cubic yards bridge-masonry........per cu. yd	8 00	24,696 00	
2,940 linear feet, 21 road-bridges........per lin. ft	25 00	73,500 00	
			98,196 00
Carried forward........	....	....	5,763,630 00

Estimated cost of section from Fort Plain, station 840, *to lock* 29, *stations* 1959 + 60.

Quantities and items.	Price.	Amount.	Total.
Brought forward........	....	....	$5,763,630 00
2,639,200 cubic yards earth-excavation........per cu. yd.	$0 28	$738,976 00	
29,000 cubic yards rock excavation........do....	1 00	29,000 00	
132,400 cubic yards puddling........do....	30	39,720 00	

Estimated cost of section from Fort Plain, &c.—Continued.

Quantities and items.	Price.	Amount.	Total.
170,504 cubic yards slope-wall....per cu. yd.	$1 75	$298,382 00	
146,278 cubic yards lining....do....	50	73,139 00	
31,100 cubic yards graveling, tow-path....do....	50	15,550 00	
			$1,194,767 00
Fort Plain aqueduct.			
341 cubic yards masonry....per cu. yd.	4 00	1,364 00	
1,298 cubic yards masonry....do....	9 00	11,682 00	
13 cubic yards masonry, coping....do....	13 00	169 00	
25,300 feet, board-measure, hemlock....per 1,000 ft	20 00	506 00	
255,350 feet, board-measure, oak....do....	60 00	15,321 00	
40,000 feet, board-measure, pine....do....	45 00	1,800 00	
23,400 pounds iron....per lb	06	1,404 00	
			32,246 00
Canajoharie aqueduct.			
341 cubic yards masonry....per cu. yd	4 00	1,364 00	
1,298 cubic yards masonry....do....	9 00	11,682 00	
13 cubic yards masonry, coping....do....	13 00	169 00	
25,300 feet, board-measure, hemlock....per 1,000 ft.	20 00	506 00	
255,350 feet, board-measure, oak....do....	60 00	15,321 00	
40,200 feet, board-measure, pine....do....	45 00	1,809 00	
23,400 pounds iron....per lb.	06	1,404 00	
			32,255 00
Spraker's aqueduct.			
341 cubic yards masonry....per cu. yd	4 00	1,364 00	
1,298 cubic yards masonry, face-work....do....	9 00	11,682 00	
14 cubic yards masonry, coping....do....	13 00	182 00	
25,300 feet, board-measure, hemlock....per 1,000 ft.	20 00	506 00	
255,350 feet, board-measure, oak....do....	60 00	15,321 00	
40,200 feet, board-measure, pine....do...	45 00	1,809 00	
23,400 pounds iron....per lb	06	1,404 00	
			32,268 00
Auriesville aqueduct.			
326 cubic yards masonry....per cu. yd.	4 00	1,304 00	
1,035 cubic yards masonry....do....	9 00	9,315 00	
11 cubic yards masonry, coping....do...	13 00	143 00	
22,650 feet, board-measure, hemlock....per 1,000 ft	20 00	453 00	
217,800 feet, board-measure, oak....do....	60 00	13,068 00	
34,200 feet, board-measure, pine....do...	45 00	1,539 00	
19,950 pounds iron....per lb	06	1,197 00	
			27,019 00
Schoharie Creek aqueduct.			
2,581 cubic yards masonry....per cu. yd.	4 00	10,324 00	
3,747 cubic yards masonry....do...	9 00	33,723 00	
59 cubic yards masonry, coping....do...	13 00	767 00	
775,000 feet, board-measure, oak....per 1,000 ft	60 00	46,500 00	
134,000 feet, board-measure, pine....do....	45 00	6,030 00	
77,350 pounds iron....per lb	06	4,641 00	
			101,985 00
5,476 cubic yards bridge-masonry....per cu. yd	8 00	43,808 00	
4,620 linear feet, 33 road-bridges....per lin. ft	25 00	115,500 00	
280 linear feet, 2 road-bridges....do....	28 00	7,840 00	
Do....do...	38 00	10,640 00	
			177,788 00
220 cubic yards masonry, arch-culvert....per cu. yd	9 00	1,980 00	
12,000 feet, board-measure, hemlock timber....per 1,000 ft.	20 00	240 00	
5,000 feet, board-measure, plank....do...	20 00	100 00	
100 pounds iron spikes and nails....per lb	06	6 00	
			2,326 00
220 cubic yards masonry, arch-culvert....per cu. yd	9 00	1,980 00	
12,000 feet, board-measure, hemlock timber....per 1,000 ft	20 00	240 00	
5,000 feet, board-measure, hemlock plank....do...	20 00	100 00	
100 pounds spikes and nails....per lb	06	6 00	
			2,326 00
200 cubic yards masonry, arch-culvert....per cu. yd	9 00	1,800 00	
10,000 feet, board-measure, hemlock timber....per 1,000 ft	20 00	200 00	
4,000 feet, board-measure, hemlock plank....do....	20 00	80 00	
100 pounds spikes and nails....per lb.	06	6 00	
			2,086 00
200 cubic yards masonry, arch-culvert....per cu. yd	9 00	1,800 00	
10,000 feet, board-measure, hemlock timber....per 1,000 ft	20 00	200 00	
4,000 feet, board-measure, hemlock plank....do...	20 00	80 00	
100 pounds iron spikes and nails....per lb	06	6 00	
			2,086 00
740 cubic yards masonry in waste-weir....per cu. yd.	9 00	6,660 00	
166,900 feet, board-measure, hemlock timber....per 1,000 ft	20 00	3,338 00	
34,000 feet, board-measure, hemlock plank....do...	45 00	1,530 00	
500 pounds iron spikes and nails....per lb	06	30 00	
			11,558 00

Estimated cost of section from Fort Plain, &c.—Continued.

Quantities and items.	Price.	Amount.	Total.
635 cubic yards masonry in waste-weir ....per cu. yd	$9 00	$5,715 00	
20,000 feet, board-measure, oak timber ....per 1,000 ft	60 00	1,200 00	
181,800 feet, board-measure, hemlock ....do	20 00	3,636 00	
41,000 feet, board-measure, pine ....do	45 00	1,845 00	
600 pounds iron spikes and nails ....per lb	06	36 00	
			$12,432 00
750 cubic yards masonry in waste-weir ....per cu. yd	9 00	6,750 00	
25,000 feet, board-measure, oak timber ....per 1,000 ft	60 00	1,500 00	
42,000 feet, board-measure, pine ....do	45 00	1,890 00	
184,000 feet, board-measure, hemlock ....do	20 00	3,680 00	
600 pounds iron spikes and nails ....per lb	06	36 00	
			13,856 00
Small waste-weirs.			
12 cubic yards masonry ....per cu. yd	6 70	72 00	
2,000 feet, board-measure, pine ....per 1,000 ft	45 00	90 00	
50 pounds iron spikes and nails ....per lb	06	3 00	
			165 00
12 cubic yards masonry ....per cu. yd	6 00	72 00	
2,000 feet, board-measure, pine ....per 1,000 ft	45 00	90 00	
50 pounds iron spikes and nails ....per lb	06	3 00	
			165 00
12 cubic yards masonry ....per cu. yd	6 00	72 00	
2,000 feet, board-measure, pine ....per 1,000 ft	45 00	90 00	
50 pounds iron spikes and nails ....per lb	06	3 00	
			165 00
Carried forward	......	......	7,409,123 00

Estimated cost of section from lock 29, station 1959 + 60, *to lock* 23, *station* 2928 + 63.

Quantities and items.	Price.	Amount.	Total.
Brought forward	......	......	$7,409,123 00
2,244,500 cubic yards earth-excavation ....per cu. yd	$0 28	$628,460 00	
42,000 cubic yards rock-excavation ....do	1 00	42,000 00	
112,400 cubic yards puddling ....do	30	33,720 00	
148,332 cubic yards slope-wall ....do	1 75	259,581 00	
137,144 cubic yards lining ....do	50	68,572 00	
26,918 cubic yards graveling, tow-path ....do	50	13,459 00	
			1,045,792 00
Port Jackson aqueduct.			
557 cubic yards masonry ....per cu. yd	4 00	2,228 00	
435 cubic yards masonry, face-work ....do	9 00	3,915 00	
663 cubic yards masonry, concrete ....do	5 00	3,315 00	
6 cubic yards masonry, coping ....do	13 00	78 00	
11,600 feet, board-measure, hemlock ....per 1,000 ft.	20 00	232 00	
			9,768 00
Philips aqueduct.			
326 cubic yards masonry ....per cu. yd	4 00	1,304 00	
1,035 cubic yards masonry, face-work ....do	9 00	9,315 00	
12 cubic yards masonry, coping ....do	13 00	156 00	
21,650 feet, board-measure, hemlock ....per 1,000 ft	20 00	433 00	
217,800 feet, board-measure, oak ....do	60 00	13,068 00	
34,200 feet, board-measure, pine ....do	45 00	1,539 00	
19,950 pounds iron spikes and nails, &c ....per lb	06	1,197 00	
			27,012 00
Sansai Kill aqueduct.			
288 cubic yards masonry ....per cu. yd	4 00	1,152 00	
771 cubic yards masonry, face-work ....do	9 00	6,939 00	
10 cubic yards masonry, coping ....do	13 00	130 00	
18,050 feet, board-measure, hemlock ....per 1,000 ft	20 00	361 00	
157,700 feet, board-measure, oak ....do	60 00	9,462 00	
24,800 feet, board-measure, pine ....do	45 00	1,116 00	
14,500 pounds iron ....per lb	06	870 00	
			20,030 00
2,520 linear feet, 18 road-bridges ....per lin. ft	25 00	63,000 00	
280 linear feet, 2 road-bridges ....do	35 00	9,800 00	
3,080 cubic yards bridge-masonry ....per cu. yd	8 00	24,640 00	
			97,440 00
455 cubic yards culvert-masonry ....per cu. yd	9 00	4,095 00	
35,000 feet, board-measure, hemlock ....per 1,000 ft	20 00	700 00	
100 pounds spikes and nails ....per lb	06	6 00	
			4,801 00

From lock 29, station 1959 + 60, *to lock* 23, *&c.*—Continued.

Quantities and items.	Price.	Amount.	Total.
380 cubic yards culvert-masonry ... per cu. yd.	$9 00	$3,420 00	
25,000 feet, board-measure, hemlock ... per 1,000 ft	20 00	500 00	
100 pounds spikes and nails ... per lb.	06	6 00	
			$3,926 00
195 cubic yards culvert-masonry ... per cu. yd.	9 00	1,755 00	
10,700 feet, board-measure, hemlock ... per 1,000 ft	20 00	214 00	
50 pounds spikes and nails ... per lb	06	3 00	
			1,972 00
195 cubic yards culvert-masonry ... per cu. yd	9 00	1,755 00	
10,700 feet, board-measure, hemlock ... per 1,000 ft.	20 00	214 00	
50 pounds spikes and nails ... per lb.	06	3 00	
			1,972 00
300 cubic yards culvert-masonry ... per cu. yd	9 00	2,700 00	
20,000 feet, board-measure, hemlock ... per 1,000 ft.	20 00	400 00	
100 pounds spikes and nails ... per lb.	06	6 00	
			3,106 00
300 cubic yards culvert-masonry ... per cu. yd.	9 00	2,700 00	
20,000 feet, board-measure, hemlock ... per 1,000 ft	20 00	400 00	
100 pounds spikes and nails ... per lb	06	6 00	
			3,106 00
Carried forward ...			8,628,048 00

Estimated cost of section from lock No. 23, *station* 2928 + 63, *to lock* 18, *station* 4095 + 59.

Quantities and items.	Price.	Amount.	Total.
Brought forward ...			$8,628,048 00
2,370,000 cubic yards earth-excavation ... per cu. yd	$0 28	$663,600 00	
450,000 cubic yards rock-excavation ... do ...	1 00	450,000 00	
113,400 cubic yards puddling ... do ...	30	34,020 00	
12,210 cubic yards vertical wall ... do ...	5 00	61,050 00	
169,484 cubic yards slope-wall ... do ...	1 75	296,597 00	
148,000 cubic yards lining ... do ...	50	74,000 00	
32,414 cubic yards graveling, tow-path ... do ...	50	16,207 00	
			1,595,474 00
Upper Mohawk aqueduct.			
2,643 cubic yards masonry, foundation and backing ... per cu. yd	4 00	10,572 00	
2,749 cubic yards masonry, face-work ... do ...	9 00	24,741 00	
50 cubic yards masonry, coping ... do ..	13 00	650 00	
745,150 feet oak, board-measure ... per 1,000 ft.	60 00	44,709 00	
129,200 feet pine, board-measure ... do ...	45 00	5,814 00	
74,350 pounds iron ... per lb.	06	4,461 00	
1,259 cubic yards rock-excavation ... per cu. yd.	2 00	2,590 00	
			93,537 00
Lower Mohawk aqueduct.			
1,334 cubic yards masonry, foundation and backing ... per cu. yd	4 00	5,336 00	
4,239 cubic yards masonry, face-work ... do ...	9 00	38,151 00	
76 cubic yards masonry, coping ... do ...	13 00	988 00	
1,266,700 feet oak, board-measure ... per 1,000 ft	60 00	76,002 00	
219,600 feet pine, board-measure ... do ...	45 00	9,882 00	
126,400 pounds iron ... per lb.	06	7,584 00	
566 cubic yards rock-excavation ... per cu. yd	2 00	1,132 00	
			139,075 00
4,200 linear feet, 30 road-bridges ... per lin. ft.	25 00	105,000 00	
560 linear feet, 4 road-bridges ... do ...	34 00	19,040 00	
140 linear feet, 1 road-bridge ... do ...	42 00	5,880 00	
140 linear feet, 1 road-bridge ... do ...	46 00	6,440 00	
140 linear feet, 1 road-bridge ... do ...	75 00	10,500 00	
140 linear feet, 1 road-bridge ... do ...	80 00	11,200 00	
140 linear feet, 1 railroad-bridge ... do ...	35 00	4,900 00	
140 linear feet, 1 railroad-bridge ... do ...	100 00	14,000 00	
7,220 cubic yards bridge-masonry ... per cu. yd.	8 00	57,760 00	
			234,720 00
195 cubic yards culvert-masonry ... per cu. yd.	9 00	1,755 00	
14,000 feet hemlock, board-measure ... per 1,000 ft.	20 00	280 00	
50 pounds spikes and nails ... per lb.	06	3 00	
			2,038 00
915 cubic yards arch-culvert masonry ... per cu. yd.	9 00	8,235 00	
43,400 feet hemlock, board-measure ... per 1,000 ft.	20 00	868 00	
200 pounds spikes and nails ... per lb.	06	12 00	
			9,115 00
890 cubic yards arch-culvert masonry ... per cu. yd	9 00	8,010 00	
42,000 feet hemlock, board-measure ... per 1,000 ft.	20 00	840 00	
200 pounds spikes and nails ... per lb.	06	12 00	
			8,862 00
195 cubic yards arch-culvert masonry ... per cu. yd.	9 00	1,755 00	
14,000 feet hemlock, board-measure ... per 1,000 ft.	20 00	280 00	
50 pounds spikes and nails ... per lb.	06	3 00	
			2,038 00

From lock No. 23, *station* 2928+63, *to lock* 18, *&c.*—Continued.

Quantities and items.	Price.	Amount.	Total.
192 cubic yards box-culvert masonry........................per cu. yd.	$4 00	$768 00	
14,000 feet of hemlock, board-measure....................per 1,000 ft.	20 00	280 00	
50 pounds spikes and nails ....per lb	06	3 00	$1,051 00
195 cubic yards arch-culvert masonry......................per cu. yd	9 00	1,755 00	
10,000 feet hemlock, board-measure ....per 1,000 ft.	20 00	200 00	
50 pounds spikes and nails......................................per lb.	06	3 00	1,958 00
192 cubic yards box-culvert masonry.......................per cu. yd	4 00	768 00	
14,000 feet hemlock, board-measure ....per 1,000 ft.	20 00	280 00	
50 pounds spikes and nails......................................per lb.	06	3 00	1,051 00
448 cubic yards masonry in waste-weir ....per cu. yd.	9 00	4,032 00	
34,800 feet oak timber and plank, board-measure.........per 1,000 ft	60 00	2,088 00	
1,800 pounds iron spikes, nails, &c..............................per lb	06	108 00	6,228 00
128 cubic yards masonry in waste-weir ....per cu. yd	9 00	1,152 00	
8,300 feet oak timber and plank, board-measure ....per 1,000 ft	60 00	498 00	
200 pounds iron spikes and nails ....per lb.	06	12 00	1,662 00
1,800 feet oak, waste-weir of wood, board measure.......per 1,000 ft.	60 00	108 00	
50 pounds iron spikes and nails.................................per lb.	06	3 00	111 00
Carried forward	....	....	10,724,968 00

Estimated cost of section from lock 18, *station* 4095+59, *to lock* 13, *station* 4157+71.

Quantities and items.	Price.	Amount.	Total.
Brought forward...	....	....	$10,724,968 00
152,800 cubic yards earth-excavation.......................per cu. yd	$0 28	$42,784 00	
94,000 cubic yards rock-excavation ....do....	1 00	94,000 00	
9,482 cubic yards vertical wall..do....	5 00	47,410 00	
1,860 cubic yards slope-wall ....do....	1 75	3,255 00	
3,718 cubic yards lining ....do....	50	1,859 00	
1 726 cubic yards graveling, tow-path..............................do....	50	863 00	190,171 00
860 cubic yards masonry in bridge-abutments............per cu. yd.	8 00	....	6,880 00
140 linear feet, 1 road-bridge................................per lin. ft.	25 00	3,500 00	
140 linear feet, 1 road bridge...do....	39 00	5,460 00	
140 linear feet, 1 road-bridge...do...	43 00	6,020 00	14,980 00
Carried forward	....	....	10,936,999 00

Estimated cost of section from lock 13, *station* 4157+71, *to lock* 3, *station* 4270+8, *Troy.*

Quantities and items.	Price.	Amount.	Total.
Brought forward	....	....	$10,936,999 00
52,500 cubic yards earth-excavation.......................per cu. yd.	$0 28	$14,700 00	
132,600 cubic yards rock-excavation ....do....	1 00	132,600 00	
10,500 cubic yards puddling ....do....	30	3,150 00	
13,544 cubic yards slope-wall ....do....	1 75	23,702 00	
11,608 cubic yards lining ....do....	50	5,804 00	
3,124 cubic yards graveling, tow-path ....do...	50	1,562 00	181,518 00
280 linear feet, 2 bridges, superstructure...................per lin. ft	25 00	7,000 00	
140 linear feet, 1 bridge, superstructure..........................do....	35 00	4,900 00	
140 linear feet, 1 bridge, superstructure ....do...	45 00	6,300 00	
744 cubic yards bridge-masonry ....per cu. yd	6 00	4,464 00	
195 cubic yards arch-culvert masonry ....do ...	9 00	1,755 00	
10,800 feet hemlock, board-measure.......................per 1,000 ft.	20 00	216 00	
50 pounds iron, spikes and nails ....per lb	06	3 00	24,638 00
330 cubic yards arch-culvert masonry......................per cu. yd	9 00	2,970 00	
16,500 feet hemlock timber and plank, board-measure...per 1,000 ft	20 00	330 00	
50 pounds spikes and nails ....per lb.	06	3 00	3,303 00
1,800 feet oak in waste-weir, board-measure ....per 1,000 ft	60 00	108 00	
50 pounds iron spikes and nails.................................per lb	06	3 00	111 00
36 cubic yards masonry in waste-weir ....per cu. yd.	9 00	324 00	
4,900 feet oak, board-measure ....per 1,000 ft	60 00	294 00	
50 pounds spikes and nails......................................per lb	06	3 00	621 00
Carried forward	....	....	11,147,190 00

From lock 3, station 4270+08, at Troy, to station 4612+61, lower lock-gate, Albany.

Quantities and items.	Price.	Amount.	Total.
Brought forward			$11,147,190 00
1,013,600 cubic yards earth-excavation ... per cu. yd.	$0 28	$283,808 00	
117,600 cubic yards rock-excavation ... do	1 00	117,600 00	
40,400 cubic yards puddling ... do	30	12,120 00	
89,200 cubic yards vertical wall ... do	5 00	446,000 00	
20,000 cubic yards lining ... do	30	10,000 00	
9,300 cubic yards graveling, tow-path ... do	50	4,650 00	
			874,178 00
1,400 linear feet, 10 road-bridges ... per lin. ft	25 00	35,000 00	
1,540 linear feet, 11 road-bridges ... do	39 00	60,060 00	
140 linear feet, 1 road-bridge ... do	46 00	6,440 00	
140 linear feet, 1 road-bridge ... do	67 00	9,380 00	
140 linear feet, 1 railroad bridge ... do	70 00	9,800 00	
			120,680 00
4,924 cubic yards bridge-masonry ... per cu. yd	8 00		39,392 00
470 cubic yards arch culvert masonry ... do	9 00	4,230 00	
22,500 feet hemlock timber and plank, board-measure ... per 1,000 ft	20 00	450 00	
100 pounds iron, spikes and nails ... per lb.	06	6 00	
			4,686 00
348 cubic yards arch-culvert masonry ... per cu. yd	9 00	3,132 00	
14,500 feet hemlock timber and plank, board-measure ... per 1,000 ft.	20 00	290 00	
100 pounds spikes and nails ... per lb	06	6 00	
			3,428 00
42 cubic yards box-culvert masonry ... per cu. yd	4 00	168 00	
6,000 feet hemlock timber and plank, board-measure ... per 1,000 ft	20 00	120 00	
50 pounds spikes and nails ... per lb	06	3 00	
			291 00
68 cubic yards arch-culvert masonry ... per cu. yd	9 00	612 00	
6,000 feet hemlock timber and plank, board-measure ... per 1,000 ft	20 00	120 00	
50 pounds spikes and nails ... per lb.	06	3 00	
			735 00
134 cubic yards arch-culvert masonry ... per cu. yd.	9 00	1,206 00	
11,000 feet hemlock timber and plank, board-measure ... per 1,000 ft	20 00	220 00	
50 pounds spikes and nails ... per lb	06	3 00	
			1,429 00
788 cubic yards masonry, culvert and waste-weir ... per cu. yd	9 00	7,092 00	
46,000 feet hemlock timber and plank, board-measure ... per 1,000 ft.	20 00	920 00	
28,000 feet oak timber and plank, board-measure ... do	60 00	1,680 00	
20,000 feet pine plank, board-measure ... do	45 00	900 00	
500 pounds spikes and nails ... per lb	06	30 00	
			10,622 00
Waste-weir.			
4,500 feet oak timber and plank, board-measure ... per 1,000 ft	60 00	270 00	
100 pounds spikes and nails ... per lb.	06	6 00	
			276 00
Removing Troy weigh-lock			700 00
Total			12,903,607 00

Estimate of lock No. 1, Erie Canal, 15½ feet lift.

Quantities and items.	Price.	Amount.	Total.
Grubbing and clearing		$200 00	
Bailing and draining		7,000 00	
11,300 cubic yards earth-excavation ... per cu. yd.	$0 28	3,164 00	
500 cubic yards embankment ... do	28	140 00	
100 cubic yards lining ... do	50	50 00	
120 cubic yards puddling-earth ... do	30	36 00	
170 cubic yards loose stone ... do	1 50	255 00	
120 cubic yards vertical wall, in cement ... do	6 00	720 00	
120 cubic yards vertical wall, dry ... do	3 00	360 00	
4,525 cubic yards masonry in lock-walls ... do	13 00	58,825 00	
350 cubic yards concrete-masonry ... do	5 00	1,750 00	
47,600 feet, b. m., white-oak timber, &c ... per 1,000 ft.	60 00	2,856 00	
18,300 feet, b. m., white-pine timber, &c ... do	45 00	823 50	
186,000 feet, b. m., hemlock ... do	20 00	3,720 00	
19,000 linear feet bearing-piles, delivered ... per lin. ft	15	2,850 00	
18,000 linear feet bearing-piles, driven ... do	10	1,800 00	
16,500 pounds wrought iron ... per lb.	12	1,980 00	
8,500 pounds cast iron ... do	08	680 00	
4,100 pounds spikes and nails ... do	06	246 00	
Sulphur and sand cement		100 00	
Painting gates		30 00	
100 linear feet snubbing-posts ... per lin. ft	60	60 00	
			$87,645 50

Estimate of lock No. 15, Erie Canal, 10 feet lift.

Quantities and items.	Price.	Amount.	Total.
Grubbing and clearing	....	$200 00	
Bailing and draining	....	2,500 00	
6,500 cubic yards excavation of earth .... per cu. yd..	$0 28	1,820 00	
3,500 cubic yards excavation of slate-rock .... do...	1 00	3,500 00	
1,500 cubic yards embankment .... do...	28	420 00	
150 cubic yards lining .... do...	50	75 00	
400 cubic yards puddling-earth .... do...	30	120 00	
170 cubic yards loose stone .... do...	1 50	255 00	
120 cubic yards vertical wall, in cement .... do...	6 00	720 00	
140 cubic yards vertical wall, dry .... do ..	3 00	420 00	
3,328 cubic yards masonry in lock-walls .... do...	13 00	43,264 00	
350 yards concrete-masonry .... do...	5 00	1,750 00	
42,300 feet, board-measure, white-oak timber, &c .... per 1,000 ft..	60 00	2,538 00	
17,100 feet, board-measure, white-pine timber, &c .... do ..	45 00	769 50	
174,200 feet, board-measure, hemlock timber, &c .... do...	20 00	3,484 00	
12,000 pounds wrought iron .... per pound..	12	1,440 00	
8,500 pounds cast iron .... do...	08	680 00	
4,100 pounds spikes and nails .... do...	06	246 00	
Sulphur and sand cement	....	100 00	
Painting	....	30 00	
100 linear feet snubbing-posts .... per lin. ft..	60	60 00	
			$64,391 50

Estimate of lock No. 39, Erie Canal, $10\frac{1}{3}$ feet lift.

Quantities and items.	Price.	Amount.	Total.
Grubbing and clearing	......	$200 00	
Bailing and draining	......	3,000 00	
11,800 cubic yards rock-excavation, with blasting .... per cu. yd..	$1 00	11,800 00	
1,000 cubic yards embankment .... do...	28	280 00	
100 cubic yards lining .... do...	50	50 00	
100 cubic yards puddling-earth .... do...	30	30 00	
110 cubic yards slope-wall and paving .... do...	2 00	220 00	
170 cubic yards loose stone .... do...	1 50	255 00	
120 cubic yards vertical wall, in cement .... do ..	6 00	720 00	
130 cubic yards vertical wall, dry .... do...	3 00	390 00	
3,495 cubic yards masonry in lock-walls .... do...	13 00	45,435 00	
350 cubic yards concrete-masonry .... do...	5 00	1,750 00	
44,700 feet, board-measure, white-oak timber, &c .... per 1,000 ft..	60 00	2,682 00	
17,200 feet, board-measure, white-pine timber .... do...	45 00	774 00	
201,400 feet, board-measure, hemlock timber .... do...	20 00	4,028 00	
12,000 pounds wrought iron .... per pound..	12	1,440 00	
8,500 pounds cast iron .... do...	08	680 00	
4,100 pounds spikes and nails .... do...	06	246 00	
Sulphur and sand cement	......	100 00	
Painting	......	30 00	
100 linear feet snubbing-posts .... per lin. ft..	60	60 00	
			$74,170 00

Estimated cost of lock No. 44, Erie Canal, $10\frac{1}{2}$ feet lift.

Quantities and items.	Price.	Amount.	Total.
Grubbing and clearing	......	$200 00	
Bailing and draining		1,500 00	
9,200 cubic yards excavation of earth .... per cu. yd..	$0 28	2,576 00	
1,200 cubic yards embankment .... do...	28	336 00	
120 cubic yards lining .... do...	50	60 00	
130 cubic yards puddling-earth .... do...	30	39 00	
100 cubic yards slope-wall and paving .... do...	2 00	200 00	
170 cubic yards loose stone .... do...	1 50	255 00	
120 cubic yards vertical wall, in cement .... do...	6 00	720 00	
160 cubic yards vertical wall, dry .... do...	3 00	480 00	
3,425 cubic yards masonry in lock-walls .... do...	13 00	44,525 00	
350 cubic yards concrete-masonry .... do...	5 00	1,750 00	
45,000 feet, board-measure, white-oak timber, &c .... per 1,000 ft..	60 00	2,700 00	
17,200 feet, board-measure, white-pine timber .... do...	45 00	774 00	
184,800 feet, board-measure, hemlock timber .... do...	20 00	3,696 00	
19,000 linear feet bearing-piles, delivered .... per lin. ft..	15	2,850 00	
16,000 linear feet bearing-piles, driven .... do...	10	1,600 00	
12,000 pounds wrought-iron .... per pound..	12	1,440 00	
8,500 pounds cast iron .... do....	08	680 00	
4,100 pounds spikes and nails .... do...	06	246 00	
Sulphur and sand cement	....	100 00	
Painting	....	30 00	
100 linear feet snubbing-posts .... per lin. ft..	60	60 00	
			$66,817 00

Erie Canal locks and their cost.

Number.	Locks.	Amount.
1	Lift-lock, 15½ feet lift	$87,645 50
2	Lift-lock, 9¼ feet lift	63,655 00
Troy side-cut.	Lower lock, 13 feet lift	78,377 50
	Upper lock, 11 feet lift	71,136 50
3	Lift-lock, 11¼ feet lift	68,991 50
4	......do	66,840 00
5	Lift-lock, 10⅝ feet lift	67,045 00
6	Lift-lock, 10 feet lift	69,147 50
7	......do	67,863 50
8	......do	63,215 50
9	......do	64,438 50
10	......do	62,575 50
11	......do	70,816 00
12	......do	68,680 00
13	......do	64,628 50
14	......do	63,147 50
15	......do	64,391 50
16	......do	62,799 00
17	......do	65,908 50
18	Lift-lock, 10½ feet lift	68,369 50
19	Lift-lock, 8¼ feet lift	59,079 00
20	Lift-lock, 10 feet lift	67,227 50
21	Lift-lock, 11¼ feet lift	72,168 50
22	......do	66,984 50
23	Lift-lock, 8 feet lift	60,218 00
24	......do	60,362 00
25	......do	60,279 00
26	......do	61,294 00
27	......do	56,453 00
28	......do	60,376 00
29	Lift-lock, 7½ feet lift	52,904 00
30	Lift-lock, 10½ feet lift	62,742 00
31	Lift-lock, 6 feet lift	50,189 00
32	Lift-lock, 8 feet lift	56,095 00
33	Lift-lock, 6 feet lift	52,349 00
34	Lift-lock, 8 feet lift	58,025 00
35	......do	57,484 00
36	Lift-lock, 10 feet lift	63,958 50
37	......do	73,665 50
38	Lift-lock, 9½ feet lift	71,283 00
39	Lift-lock, 10½ feet lift	74,170 00
40	Lift-lock, 8 feet lift	57,448 00
41	......do	57,749 00
42	......do	61,777 00
43	......do	61,627 00
44	Lift-lock, 10½ feet lift	66,817 00
45	......do	67,864 00
46	Lift-lock, 3 feet lift	48,408 00
	Total	3,078,668 00

ONEIDA SHIP-CANAL—ERIE-CANAL SECTION.

Protection-wall on the Mohawk River.

Quantities and items.	Price.	Amount.	Total.
11,476 cubic yards, from Rome to Little Falls ....per cu. yd..	$1 75	$20,083	
63,272 cubic yards, from Little Falls to the Upper Mohawk aqueduct ....per cu. yd..	1 75	110,726	
30,000 cubic yards, from the Upper Mohawk aqueduct to lock No. 18, near Cohoes ....per cu. yd..	1 75	52,500	
			$183,309

Detailed estimate of Fish Creek feeder.

Quantities and items.	Price.	Amount.	Total.
11 miles grubbing and clearing ....per mile..	$400 00	$4,400	
11 miles bailing and draining ....do....	100 00	1,100	
920,000 cubic yards earth-excavation ....per cu. yd..	20	184,000	
1,000 cubic yards rock-excavation ....do....	1 00	1,000	
610,000 yards embankment ....do....	25	152,500	

Detailed statement of Fish Creek feeder—Continued.

Quantities and items.	Price.	Amount.	Total.
5,000 cubic yards lining .... per cu. yd..	$0 50	$2,500	
3,000 cubic yards puddling-earth .... do...	30	900	
2,000 cubic yards slope-wall .... do...	2 00	4,000	
200 cubic yards vertical wall in cement .... do...	5 00	1,000	
800 cubic yards vertical wall, dry .... do...	3 00	2,400	
20,000 feet, board-measure, hemlock timber .... per 1,000 ft..	20 00	400	
			$354,200
Mechanical structures.			
9 box-culverts .... each..	1,620	14,580	
Extension of railroad-culverts	....	5,857	
Railroad viaduct	....	939	
Culvert at station 386	....	2,250	
East Branch aqueduct	....	19,500	
Wood Creek aqueduct	....	7,500	
Canada Creek aqueduct	....	4,500	
Dam across West Branch	....	7,500	
Dam across East Branch	....	3,750	
Culvert at Beaver Creek	....	2,700	
Bridges	....	5,050	
Drop into canal	....	1,950	
			76,076
			430,276

Property-damages between Albany and Durhamville.

ONEIDA SHIP-CANAL ROUTE.

Items.	No. acres.	Price per acre.	Amount.
Durhamville	....	....	$12,000 00
Land	42.81	$100 00	4,281 00
Higginsville	....	....	8,000 00
Land	38.76	100 00	3,876 00
New London	....	....	3,000 00
Land	71.28	100 00	7,128 00
Rome	....	....	14,000 00
Land	102.89	100 00	10,289 00
Whitestown	....	....	14,600 00
Land	6.91	100 00	691 00
Yorkville	....	....	4,000 00
Land	17.21	100 00	1,721 00
Utica	....	....	417,800 00
Land	100.27	100 00	10,027 00
Frankfort	....	....	29,500 00
Land	13.13	100 00	1,313 00
Ilion	....	....	50,000 00
Mohawk	....	....	25,100 00
Land	84.16	100 00	8,416 00
Little Falls	....	....	150,000 00
Land	169.21	100 00	16,921 00
Fort Plain	....	....	21,800 00
Land	91.71	100 00	9,171 00
Canajoharie	....	....	7,500 00
Land	73.46	100 00	7,346 00
Fultonville	....	....	96,600 00
Port Jackson	....	....	48,000 00
Hoffman's Ferry	....	....	3,500 00
Land	316.85	100 00	31,685 00
Schenectady	....	....	174,000 00
Land	42.56	100 00	4,256 00
Upper Aqueduct	....	....	30,600 00
Land	142.33	100 00	14,233 00
Crescent	....	....	9,800 00
Land	34.71	100 00	3,471 00
Cohoes	....	....	93,400 00
Land	14.17	100 00	1,417 00
Cohoes to West Troy	....	....	13,000 00
West Troy	....	....	190,700 00
Port Schuyler	....	....	61,200 00
Troy Road	....	....	21,000 00
Land	25.00	300 00	7,500 00
Albany	....	....	175,000 00
Total	....	....	1,847,842 00

ONEIDA SHIP-CANAL.

First summary—From Durhamville to Albany.

Specification of estimates for—

Excavation embankment, puddling slope and vertical walls, culverts, aqueducts, bridges, and tow-paths		$12,203,607 00
Locks, including side-cut locks at Troy		3,078,668 00
Protection-walls on Mohawk River		183,309 00
		15,465,584 00
Add 10 per cent. for engineering and contingencies	$1,546,558 40	
Fish Creek feeder	430,276 00	
Land-damages	1,847,842 00	
		3,824,676 40
Total from Durhamville to Albany		19,290,260 40

Summary of the estimates for the construction of the Oneida Ship-Canal from Oswego to Albany.

Estimates.	Miles.	Cost of construction.	Land-damages.	Total cost.
Oswego to Durhamville by the cross-cut line and Oneida Lake.	61.067	$5,526,255 35		
Durhamville to lower side-cut, Troy, on the line of the Erie Canal.	134.996	16,107,857 15		
From lower side-cut, Troy, to lock No. 1, Albany Basin.	4.385	904,285 25		
Land-damages:				
Oswego to Durhamville			$397,341 50	
Durhamville to Troy			1,583,142 00	
Troy to Albany			264,700 00	
Total	200.448	22,538,397 73	2,245,183 50	$24,783,581 25
Fish Creek feeder				430,276 00
Grand total				25,213,857 25
Oswego to Durhamville by the Oneida River and Oneida Lake.	68.555	4,509,131 55		
Durhamville to lower side-cut, Troy, on the line of the Erie Canal.	134.996	16,107,857 15		
From lower side-cut, Troy, to lock No. 1, Albany Basin.	4.385	904,285 25		
Land-damages:				
Oswego to Durhamville			452,320 50	
Durhamville to Troy			1,583,142 00	
Troy to Albany			264,700 00	
Total	207.936	21,521,273 95	2,300,162 50	23,821,436 45
Fish Creek feeder				430,276 00
Grand total				24,251,712 45

THE CHAMPLAIN SHIP-CANAL ROUTE.

REPORT OF MR. C. A. FULLER, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Oswego, December 18, 1874.

SIR: In compliance with your instructions of August 3, 1874, I have the honor herewith to submit a report, with maps, plans, and estimates, on the proposed enlarged water-route from the Saint Lawrence River to Troy on the Hudson River.

This route includes a ship-canal from Caughnawaga, on the Saint Lawrence, to Saint John's, on the Richelieu River; the Richelieu River and Lake Champlain to Whitehall, N. Y.; a ship-canal from Whitehall to Fort Edward, on the Hudson River; and slack-water navigation from Fort Edward to Troy.

By the plans and estimates herewith presented, it is contemplated to construct a ship-canal from Caughnawaga to the Chambly Canal, a distance of 23.62 miles; to enlarge the Chambly Canal to Saint John's, 8.88 miles; to deepen the Richelieu River, where necessary, between Saint John's and Rouse's Point, on Lake Champlain, a distance of 22 miles; to adopt the present channel through that lake to Whitehall, 111 miles in length; to construct a new ship-canal from Whitehall to Fort Edward, 24.13 miles long; and to slack-water the Hudson River thence to Troy, a distance of 39.8 miles; making the entire distance from the Saint Lawrence River, by the proposed route, to tide-water at Troy, 229.43 miles.

This distance may be divided as follows:

	Miles
Canal navigation	56.63
River navigation	61.80
Lake navigation	111.00
Total	229.43

Your instructions not contemplating a regular survey of the proposed route, I have relied for the data on which my estimates are based on a personal reconnaissance of the entire line, and on maps, plans, and reports of surveys previously made, together with the results of a preliminary survey of the line between Whitehall and Fort Edward, made under my direction, during the months of September and October last.

In this report I propose to divide the subject into four parts, discussing each division under its proper head, and submitting estimates of the cost of each part of the work separately, to wit:

	Miles.
1. The Canada division, from Saint Lawrence to Lake Champlain	54.50
2. The Champlain division, from Rouse's Point to Whitehall	111.00
3. The Canal division, from Whitehall to Fort Edward	24.13
4. The Hudson River division, from Fort Edward to Troy	39.80

CANADA DIVISION.

As this division lies without the jurisdiction of the United States it is not expected that I should, myself, make any estimates as to the cost of its construction. A description of the proposed route, together with an estimate of cost, as furnished by the president of the canal company, is all I propose to submit under this head.

For the purpose of making a navigable connection between the Saint Lawrence River and the waters of Lake Champlain, a company with the Hon. John Young, of Montreal, as president, was incorporated by special act of the Canadian Parliament in 1870, under the title of the "Caughnawaga Ship-Canal Company," with a capital of $300,000, limited. This company was given full authority to construct the proposed canal, and to enter upon and enlarge the Chambly Canal to the desired dimensions.

Accurate surveys of several lines proposed for this canal had been previously made by Mr. J. B. Mills, a distinguished civil engineer, and a report giving his opinion of the work, as well as his estimates of its cost, was submitted to the Canadian Government. After careful examination by several eminent civil engineers, his survey of the route was approved and adopted.

The domicile of the company being at Montreal, I visited that city in August last for the purpose of obtaining all possible data with respect to the proposed route. Mr. Young, the president of the company, very kindly and courteously gave me such reports, maps, estimates, &c., as he was able to furnish, including a map and profile of the route as surveyed and adopted, together with much interesting and valuable verbal information, and also assisted me in a thorough reconnaissance of the route between Caughnawaga and Saint John's.

The line selected by Mr. Mills appears to have been well located, the natural formation of the country being remarkably adapted to the purpose. The excavations will be comparatively light and mostly in earth, except in the vicinity of the Indian village of Caughnawaga, where some rock-cutting will be required.

The level of the Saint Lawrence River at Caughnawaga is about 29 feet below that of Lake Champlain, requiring three locks to attain the summit-level of the canal. Two of these are located near the river, with lifts of 9 and 10 feet respectively. The third, about eight and one-half miles distant from the river, will have a lift of 10 feet. The summit-level thus attained is carried to the intersection with the Chambly Canal, and thence through that canal to the Richelieu River.

Five aqueducts, two water-weirs, twenty culverts, and twelve bridges will be required on this line.

The prism of the proposed Caughnawaga and enlarged Chambly Canal is to be of the same dimensions as those of the enlarged Welland, viz, 100 feet wide at the bottom, about 150 feet in width at surface of water, and 13 feet in depth, with locks 270 feet by 45 by 12 feet on the lower miter-sills.

Mr. Mills's original estimate was based on the dimensions of the existing Saint Lawrence canals, viz, locks 200 by 45 feet, with 9 feet on the miter-sills, and amounted in the aggregate to $1,814,408 (gold). An estimate, recently made by Walter Shanley, esq., an eminent civil engineer, at the request of the Hon. John Young, president of the company, and kindly forwarded to me by the latter, makes the amount required for the construction of the canal and the enlargement of the Chambly to Saint John's, $5,500,000 (gold). The excess of this estimate over that made by Mr. Mills is due to the enlarged dimensions of the proposed canals, as well as to the increased cost of labor and materials at the present time over that ruling in the year 1848, the date of Mr. Mills's report.

Some slight dredging will be required between Saint John's and Lake Champlain, which, as estimated by Mr. Young, will cost about $35,000, making the total cost of the Canada division $5,535,000 (gold).

LAKE CHAMPLAIN DIVISION.

On this division, viz, from Rouse's Point to Whitehall, the terminus of the present Champlain Canal, the route will follow the natural channel through which, it is believed, a depth of not less than 12 feet water can be found. I have not been able to obtain accurate soundings through the entire length of this channel from any available sources of information. The charts published by the United States Coast Survey Department give an ample depth of water, so far as they have been furnished. The soundings in the basin at Whitehall, the head of the lake, give 12 feet water, and propellers of that draught have passed through the lake the past season, and arrived at the Whitehall pier. Should an increased depth of water be required in any portion of the lake-channel, it can be had at comparatively slight expense by dredging.

The Caughnawaga Canal will depend upon Lake Champlain for its water-supply, which will be ample for all the requirements for lockage, evaporation, leakage, &c.

This lake is fed on the west by the Saranac, Au Sable, Chazy, and Bouquet Rivers, and by Lake George; the latter being about thirty-six miles in length, with a maximum width of about three miles, and an elevation above the level of Lake Champlain of 158 feet. The affluents on the east are Otter Creek, Missisque, La Morelle, and Onion Rivers. On the south it is now fed by Wood Creek; but on the completion of the proposed canal it will have, in addition, a portion of the water from the summit-level, supplied from the headwaters of the Hudson, which alone would be sufficient for the demands for lockage and leakage in the Caughnawaga. The volume received from Lake George and the other affluents will be largely in excess of the amount required to cover evaporation, &c., of both the lake and the canal.

CANAL DIVISION.

At Whitehall commences the improvement proper of that portion of the route lying within the boundaries of the United States. From this point to Fort Edward, a distance of 24.13 miles, it is proposed to construct a new canal in connection with the improvement of the navigation of a portion of Wood Creek.

On my first reconnaissance between these two points, my attention was particularly directed to the condition and capabilities of the present Champlain Canal, with a view to its enlargement. A careful and thorough examination of this canal, throughout its entire length, satisfied me that to make it conform to the requirements of a ship-canal would involve many changes in its alignment, as well as in its depth and width, to enable it to pass vessels drawing 12 feet water. Its summit-level also was apparently from 10 to 15 feet higher than it should have been, if properly located, necessitating an extra lockage up and down. A further reconnaissance suggested that a better line farther to the east, following the valleys of Wood and Little Wood Creeks, might be found, provided that the natural summit between these two streams was not too high for the purpose. This could be determined only by an instrumental survey; and not being prepared to make such an examination at the time, I thankfully accepted the offer of Mr. A Barkley, canal commissioner, that he would have a preliminary line run by one of his assistants, and would furnish me with a map and profile of the same. This duty, with consent of the State engineer, Mr. Sweet, was very satisfactorily performed by Mr. G. Thomas Hall, civil engineer, under my directions.

The result of this survey shows that the natural summit between the two creeks mentioned is 145 feet above tide-water, or 49 feet above Lake Champlain, and 29 feet above the Hudson River, at Fort Edward.

By making the summit-level of the new canal 135 feet above tide, it will be 12 feet lower than that of the Champlain Canal, and it can be attained by means of three locks, from the level of Lake Champlain, of 15, 12, and 12 feet lift, respectively. The descent to the level of the Hudson will be made by one lock of 17 feet lift.

The deepest excavation for the bottom of the canal at the summit will be 23 feet, or for the tow-path and berme-bank, 6 feet.

Accordingly I abandoned the idea of enlarging the present Champlain Canal, and decided on recommending the construction of a new one in the valleys of these two creeks, making use of the creeks themselves for slack-water navigation where feasible.

LOCATION OF THE CANAL.

In making the location and estimate on this division, I was compelled to depend principally on the map and center-line profile made by Mr. Hall, aided by personal knowledge of the nature and characteristics of the country, gained by my reconnaissances of the route.

In locating, I have not confined the alignment strictly to the preliminary line run, as the general features of the country permit a change within certain limits, without greatly varying the amounts of excavation required. While the estimates are sufficiently accurate for an approximate location, a regular survey of the entire line will be required to determine the alignment, as well as the position of the locks, weirs, &c. The creeks should also be gauged at different stages of water, from the lowest to the highest, that their capacities may be accurately determined.

With these remarks, I proceed to describe the canal as approximately located.

Commencing at Whitehall, a lock of the dimensions adopted for this improvement, with a lift of 15 feet, will be constructed on the site of the three combined locks of the Champlain Canal. In connection with the lock, a dam 125 feet in length is to be built, extending to the east bank of Wood Creek, its crest being 15 feet above the level of Lake Champlain.

This dam will give the required level to lock No. 14, a distance of 3.83 miles. A vertical wall, extending from the upper end of the west wing-wall of the lock to the first cut-off in Wood Creek, will limit the basin or harbor of Whitehall on that side, and will afford easy access to the lock.

From the upper end of this vertical wall, the line will cut off a long bend in the creek. Thence, after following the creek for a few hundred feet, a cut will be made across the next long bend, and thence the line will follow the channel to near the mouth of Greenville River, the waters of which will be utilized to supply in part the requirements of lock No. 15 at Whitehall.

Thence the line follows the general direction of the channel, cutting off projecting points where necessary, to the cut-off on which lock No. 14 is located. A lift of 12 feet at this lock will raise the canal to the next level, which is continued, following the channel of the creek as closely as practicable, a distance of 5.55 miles, to lock No. 13. A lift of 12 feet at this lock brings the canal to its summit-level, which is continued to lock No. 12 at Fort Edward.

At a poit near Smith's Basin, the line leaves Wood Creek, crossing the natural summit to Little Wood Creek, and entering the latter at a point about three and one-half miles from the former. Thence it follows the channel of Little Wood Creek, as closely as practicable, to Fort Edward.

PRISM.

The prism of the canal will be 100 feet in width at bottom, about 150 feet wide at the surface, with 13 feet depth of water. Side slopes in earth-excavation of two horizontal to one vertical; in rock-cutting an inclination of one fourth to one. Tow-path and berme-banks, 4 feet above the surface-level, 15 feet in width each, with a fall to the rear of 1 foot. Exterior slopes the same as those of the interior. In embankments, a puddle-wall 3 feet in thickness will be carried up at the same time the banks are formed, extending at least 1 foot above the surface of water in the canal and from 2 to 3 feet below the natural surface of the ground, the depth depending upon the nature of the soil.

DAMS.

One dam is to be constructed at Whitehall, 125 feet long, and about 20 feet high. It will be similar in construction to those proposed for the Hudson River division, the details of which are given under the appropriate head.

LOCKS.

The locks are to be 270 feet between the gate-quoins, and 45 feet in width between the side walls at the level of the lower flow-line. They are to be constructed of dressed stone masonry, laid throughout in hydraulic-cement mortar.

Foundation-timbers in earth, to be of hemlock timber 12 inches square, to reach across the lock-pit from out to out of walls to be placed 1 foot apart except at the miter-sill platforms, where they will be laid solid. The spaces between the timbers to be filled with concrete.

Two ranges of mud-sills, 12 inches by 12, will also be placed longitudinally under each of the side walls.

The miter-sill platform to be made of timber 12 inches square, well jointed and secured with wrought-iron screw-bolts 1¼ inches in diameter.

Five puddle-trenches, for the reception of the sheet-piling, will be laid across the foundation.

The flooring will consist of two courses of pine plank, the lower 3 inches thick, to cover the entire foundation-timbers; the upper 2 inches thick, to be laid between the side walls of the chamber and at the ends of the lock; to be jointed with a plane and wedged up so as to make water-tight joints.

The miter-sills to be of white-oak, properly squared and dressed with a plane.

In rock-cutting the foundation-timbers will extend only across the chamber, and 1 foot under the side walls at each end; the wall being well bedded on concrete. In place of puddle-trenches and sheeting-piles, stop-waters of timber, 12 inches wide, will be substituted.

Masonry.—The chamber walls are to be 10 feet wide at bottom, with counterforts in rear (except in rock cuts), projecting 3 feet; 6 feet long in line of wall and about 6 feet apart. In rock-cutting, the space between the back of the walls and the face of the rock to be well filled with concrete, carried up at the same time with the walls.

The recesses are to be 2 feet 8 inches deep at the top, and the walls 11 feet wide at the bottom, carried up plumb. The chamber and wing walls to have a batter of 1 in 24, and as a general thing carried up 2 feet above the level of the upper reach.

There are to be eight chain-wells or man-holes; the wells 2 feet square inside, the bottom to slope toward the lock, to prevent the gate-chain, when slack, from lodging in them.

Breast-walls.—The breast-walls, about 7 feet wide at bottom and 3 feet at top, to be carried up to within 6 inches of the bottom of the upper reach; to be constructed of rubble-masonry and suitably coped.

LOCK-GATES.

The gates are to be of solid timber, oak and pine, made to move on a pivot and socket, and upon a cast-iron adjustable toe-roller, running on an iron traverse-circle and moved by chains and winches. At top they are to be held in place by the usual wrought-iron collar arrangement.

The timber is to be 24 inches thick at bottom, and 20 at top. The top and bottom bars, the bar forming the top of the valve opening, and intermediate bars, varying in number with the height of the gates, to be of oak, the remainder of pine; so laid as to make water-tight joints. To be secured at every point by water-tight dowels, and with wrought-iron bolts 2 inches in diameter, extending through from top to bottom.

The gates will also be strengthened by means of white-oak binders, one on each side at both ends, and by horizontal fenders of oak.

Sluice-gates.—In each of the openings between the lower bars, which are 2 feet 6 inches in depth by 8 feet 9 inches in length, will the placed in iron sluice-gates, working on a horizontal central shaft, and moving by a lifting-screw.

REGULATING-WEIRS.

Regulating-weirs, in connection with locks Nos. 12, 13, and 14, will be constructed in conformity to the general plan of weir herewith submitted; the masonry to be of the same quality as that of the locks.

At lock No. 15 (Whitehall), no weir has been provided for in my estimates. It is supposed that the dam, with a crest of 125 feet in length, will, in connection with the lock-sluices, be sufficient to provide for all the water in case of a flood in Wood Creek. The walls of the lock are to be carried up above flood-height, or about 8 feet above the crest of the dam.

I have not been able to obtain any data from which to calculate the volume of water carried by Wood Creek and Greenville River, in the season of freshets; but from the great increase in capacity to be given to the stream by the proposed improvements, I am of the opinion that the means now provided will be ample to prevent overflow.

Whenever a regular survey shall be made of this line, the flow of these streams will be determined, and if then proved necessary, a regulating-weir can be placed at or near the west side of the lock in question, with a culvert debouching into the basin below.

BRIDGES.

Fifteen bridges will be required on this division, all but one of which must be swung or pivot bridges. Of these, two will be for single-track railroads, viz, one for the Rutland Railroad, at Whitehall, and one for a branch of the Rensselaer and Saratoga Railroad at Smith's Basin.

The spans of all the pivot-bridges will be 190 feet, carried 10 feet in the clear above the level of the tow-path.

The center pier will be circular, leaving a clear water-way of 65 feet on each side. It will be laid, except where the bottom is rock, on a timber and concrete foundation, with suitable piling, and carried up with coursed masonry, laid in hydraulic-cement mortar; the top to be properly coped with ashlar not less than 15 inches in thickness, and provided with a pivot-stone not less than 6 feet square and 2 feet depth of bed. On rock-bottom, the bottom of the wall will be bedded on concrete.

The abutment walls to be of similar class of masonry, and laid where necessary on timber and plank foundations.

The highway bridges will have a roadway of 20 feet, and the tow-path and road-bridge the same width, with a span of 75 feet.

The superstructure, in all cases, to be of iron.

PROPERTY DAMAGES.

This item of estimate is comparatively small. No town property of any great value will be taken, except at Whitehall, where the requirements of lock No. 15 will render the purchase and removal of a block of buildings necessary. A careful valuation has been made of these buildings, and the amount thereof, viz, $65,000, given in the estimate. Two buildings will be removed at Fort Edward, at an estimated expense of $1,500. A portion of the land required belongs to the State of New York; the remainder has been valued at from $100 to $500 per acre.

FORT EDWARD DAM AND FEEDER.

It was my first intention to supply the summit-level of this canal through the present Glen's Falls feeder; but, on examination, the locks, sluices, and prism of the feeder, which is twelve miles in length, were found to be inadequate for the purpose. To render this feeder available, it would be necessary to enlarge the sluices in the bulkhead of the dam at Glen's Falls, to construct new regulating-wires and sluices around thirteen locks, and to widen and deepen the prism for a distance of twelve miles, which, with weir and sluice to connect with the new canal, it is estimated would cost $1,106,108.

The Champlain Canal, it appears, was originally supplied through the Fort Edward feeder, of about 4,300 feet in length, the water of the Hudson being raised to the desired level by a dam about 30 feet in height and 900 in length. Since the construction of the Glen's Fall feeder, an ample supply for the wants of the canal being obtained through that channel, the Fort Edward dam and feeder appears to have been used for private purposes.

I propose, therefore, to build a new dam, at or near the site of the present one, to a proper height; and, while making use of the full capacity of the Glen's Falls feeder, to bring the additional quantity of water required through this old feeder to a regulating-weir near the lock at its junction with the Champlain Canal; this weir to be of sufficient capacity to pass the supply from both feeders into the next level of the Champlain Canal, a fall of 10 feet, and from thence using the present canal to its connection with the new canal, giving the bottom of the latter a fall of 1 foot per mile, and, passing over a breast-wall, entering a chamber at the side of the canal; the chamber to be 100 feet long, 85 feet wide, and its bottom at the same level as that of the canal.

This dam and feeder, including new vertical walls, and repairs to guard-lock and canal, and including also property damages, it is estimated will cost $319,978.80.

As above remarked, this feeder was originally constructed to supply the Champlain Canal, which is 10 feet above the level I intended to use for the purpose. I have no doubt but that a dam of 10 feet less height, with a connecting feeder of 2,500 feet in length, could be constructed for much less than the above estimate.

A survey of the ground can alone determine this question; and none having been made with a view to such a location, I am constrained to make my estimate on the line of the orignal feeder.

WATER-SUPPLY.

The water-supply of the canal is from the Hudson River and from Wood Creek. That from the latter, as given by McElroy, is small in comparison with the amount required. In the conditions now existing the supply from this creek is less than it will be when the affluents are all brought in on the new levels assumed. In my estimate, however, I depend only on the quantity as given by him for the Wood Creek quota, and obtain the remainder from the Hudson.

In estimating the requirements of the canal, I have provided for one hundred lockages per day, for a period of two hundred and twenty days. The locks at the summit are of 17 and 12 feet lift respectively. It is assumed that the lockage through the 12-foot lock, with leakages, and the additional supply obtained from Wood Creek below

this lock, and from Greenville River, will be ample for the requirements of lock No. 15, which has a lift of 15 feet.

We will then have—

	Cubic feet.
270 × 45.7 × 17 = 209,763′ × 100 =	20,976,300
270 × 45.5 × 12 = 147,420′ × 100 =	14,742,000
Cubic feet per day for lockages	35,718,300
Evaporation, filtration, and leakage	21,401,494
Total required daily	57,119,794
Total required per minute	39,666

For the season, 57,119,794 × 220 = 12,566,354,680 cubic feet.

To meet this demand we have—

Quota of Wood Creek per minute		6,671
Quota of Glen's Falls feeder, per State engineer's report per minute	23,375	
Less evaporation and filtration per minute	660	
		22,715
Quota of Fort Edward feeder per minute		10,280
Or total per minute		39,666

The present capacity of the Hudson River to supply this amount is believed to be ample. It could be much increased by a proper system of dams and reservoirs at the headwaters of that river, to retain the water till required, and at the same time prevent the occurrence of the usual freshets in that river.

But beyond this, a large additional supply can be obtained by diverting the water that now flows into the Saint Lawrence River.

A careful survey of this region has recently been made by Professor Benedict, and an estimate made of the additional quantity of water obtainable by a system of dams and lake-reservoirs.

The amount of water that can be thus supplied over and above that which now flows into the headwaters of the Hudson is, as estimated by Professor Benedict, 60,588,000 cubic feet per day for 220 days, equal to 13,329,360,000 cubic feet, which extra supply would be more than the total amount required for the new canal, to wit:

	Cubic feet.
Extra supply, per Professor Benedict	13,329,360,000
Amount required	12,566,354,680
An excess of	763,005,320

The construction of this canal as located will, of course, destroy the present Champlain Canal between Whitehall and Fort Edward, except the portion to be used as a feeder. To prevent the flow of water received through the Glen's Falls feeder from passing along the level northerly of its junction with the Champlain Canal, an embankment is provided for in the estimates.

Boats navigating the Glen's Falls feeder can make connection with the Hudson River through the old canal formerly used for that purpose. The locks and prism of this old branch would probably require considerable outlay to render them navigable.

A large amount of business is done on this feeder, and means should be provided to give it an outlet to the river.

The aggregate amount of estimate for the canal-division, including Fort Edward dam and feeder, is $3,776,999.10.

Estimates in detail are herewith submitted.

HUDSON RIVER DIVISION.

This division, extending from Fort Edward to Troy, it is proposed to render navigable for vessels of 12 feet draught by means of a series of dams and locks and by excavations in the channel of the river where required.

For the data on which my estimate is based for this portion of the route, I am indebted to the courtesy of the State engineer, Mr. Sweet, and his assistants, who have given me frequent opportunities to examine the maps and records of the office, and have loaned for my use such maps as I deemed would be of assistance to me in preparing my plans, and have also permitted me to make tracings of such maps as I desired, that could not be spared from the office.

Among the documents received from the State engineer's office is a very full and able report of S. McElroy, esq., C. E., with accompanying maps and profiles, of a survey made by him in 1866, and submitted to the canal board, New York State canals, in February, 1867, by J. P. Goodsell, State engineer and surveyor.

This survey was authorized by the State legislature for the purpose of determi the practicability of making the Hudson River navigable between Troy and Fort ward, with locks 225 feet long and 25 feet wide, and with stone dams. A chann feet in depth and 200 feet in width was also contemplated.

The report and maps give evidence of an elaborate and accurate survey. The was triangulated the entire distance; frequent cross-sections and soundings made levels with check levels taken. The dams and locks were located, and the chann 8 feet in depth, defined.

I have availed myself fully of the valuable information contained in the rep results of this survey, and in locating the dams have, as a general thing, given the same height and position as contemplated by Mr. McElroy.

In view of the large amount of rock-excavation required in the channel, I w hopes that it might be diminished in some degree by giving an increased height t dams, and by that means raising the surface-level of the pools. A study of the su aided by a reconnaissance of the entire length of the route, showed conclusively no additional height could be given without increasing the overflow of the ban such a degree that long and costly levees would be required for protection. I therefore adopted his proposed levels, and have estimated for excavation accordi

DAMS.

The number of dams in this division will be eleven, not including the breast- with an aggregate lift of 116 feet.

The following table exhibits their number, height, level above low-tide, and l of reaches:

Dams and locks.

Number.	Lift.	Length.	Level above low-tide at Troy.	Reach.	Channel-distance.	Remarks.
	Feet.	*Feet.*	*Feet.*	*Miles.*	*Miles.*	
1	14.25	1,100	14.25	....	....	State dam at Troy to be raised 1'.8
2	9.00	660	23.25	5.92	5.92	Near site of A. and N. R. R. bridg
3	8.50	567	31.75	1.96	7.88	
4	12.50	210	44.00	1.95	9.83	
Breast	....	700	44.00	....	....	
5	6.75	700	51.00	0.37	10.20	
Breast	....	320	51.00	....	....	
6	10.25	1,000	61.25	2.75	12.95	On rock-rift, below Mechanicsvill
7	17.00	220	78.25	0.51	13.46	Near Howland's paper-mill.
Breast (*a*)	....	330	78.25	....	....	
Breast (*b*)	....	280	78.25	....	....	
Breast (*c*)	....	280	78.25	....	....	
8	4.00	550	82.25	1.25	14.71	At Stillwater.
9	6.00	550	88.25	10.85	25.56	Below Schuylerville.
10	12.00	846	100.25	3.84	29.40	Saratoga Falls, new State dam.
11	15.75	670	116.00	2.95	32.35	At Fort Miller.
Lock 12	....	....	....	7.45	39.80	At Fort Edward.

LOCATION OF DAMS.

The location and heights of these dams were determined, in part, by the positi the natural dams of slate-rock, at which, in low water, the main fall of the occurs, and over which the current flows with the increased velocity due to the f those points. The channel between these natural dams is of nearly uniform width is comparatively deep, with but slight declivity of surface.

The character of the banks was also considered, so that the least damage to adja property by overflow would be obtained.

With one exception, viz, that of dam No. 9, they will all be built on a rock-fou tion. At and near the site of the dam last mentioned, at the head of the longest r in the series, the bottom, as far as sounded, is composed of gravel, and the esti for its foundations is made to conform to the character of the bottom.

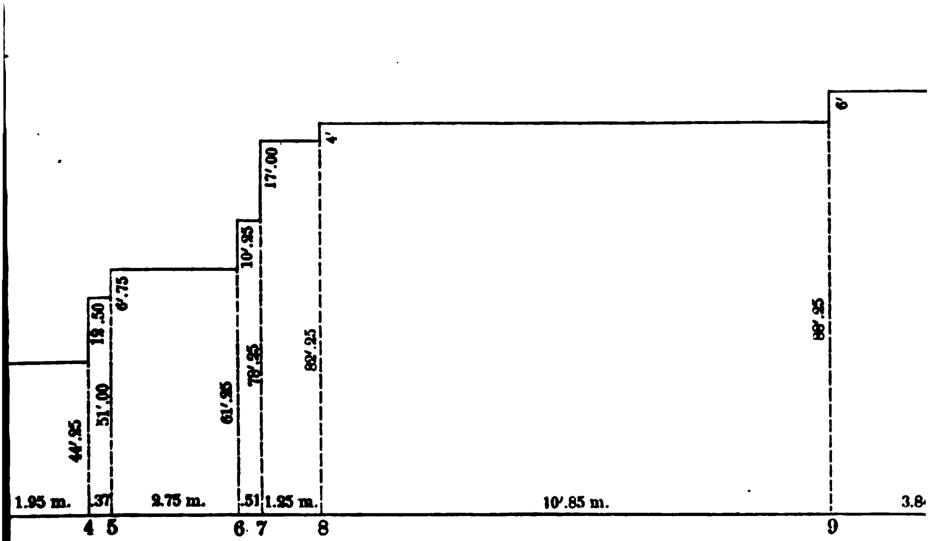
The State dam at Troy (No. 1), recently repaired, is in good condition, and will require raising about 2 feet to give it the required height of crest.

I propose, also, to adopt the new State dam (No. 10) at Saratoga Falls, as built location and level agreeing with those determined upon for a dam in that vicinity

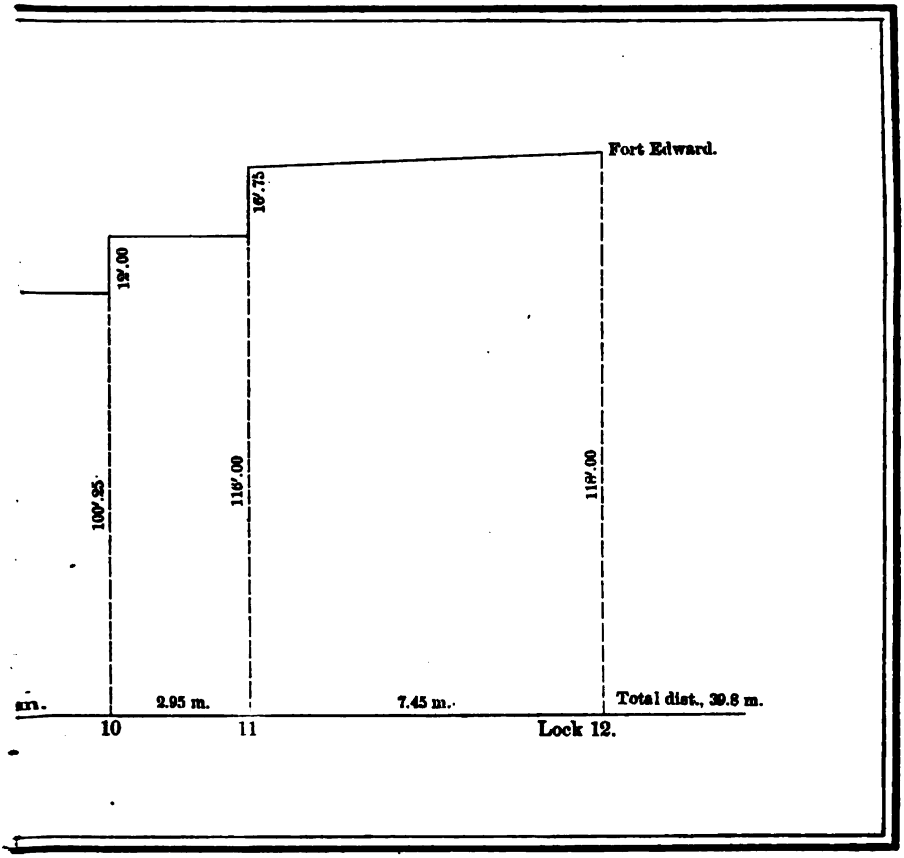
This dam has recently been constructed by the State, is of coursed stone, wi heavy coping, and will answer all the requirements of that location.

There will then be but nine dams (not including the breast-dams) to be constru in the division.

Diagram of Locks and Dams, Hudson River Division.



Horizontal scale, 4 miles to 1 inch.
Vertical " 40 feet " " "



Fort Edward.
12'.00
16'.75
100'.25
116'.00
118'.00
m.
2.95 m.
7.45 m.
Total dist., 39.8 m.
10
11
Lock 12.

PLAN OF DAMS.

The dams are to be built of heavy coursed stone, laid in hydraulic cement-mortar. The rock-foundations to be properly prepared, and the lower course of stones well laid on concrete. An ashlar coping, about 8 feet in length and 2 feet thick, cut with a bevel of 1 foot, and with rounded edges, will be well bolted to the dam, and secured with two iron clamps to each joint.

The wall will have a batter of 2 inches to the foot on the upper side, and of 4 inches to the foot on the lower. The upper slope, of broken stone and brush, to have a declivity of four horizontal to one vertical. A plank apron, secured to heavy crib-work will take the shock of the spill of the dam. The apron to be made of 12 by 12 inches pine timber, with close joints, having a slope of 4 to 1, and securely fastened to the three longitudinal top-timbers of the crib, extending the entire length of the dam. The crib to be built of hemlock and oak timber, and filled with broken stone.

The only dam on gravel-foundation (viz, No 9) will conform in structure to the others, except at the foundations. Hemlock timbers, 12 by 12 inches, placed 1 foot apart, the spaces filled with concrete, and the whole covered with pine-plank securely fastened, will form a platform for the base of the superstructure. In addition, three rows of sheet piling, of hemlock-plank 4 inches thick and 6 feet long, will be driven into the gravel; one row at the foot of the upper slope, one at the foot of the upper face of the wall, and one at the lower edge of the crib-work. They will be secured at the top by spikes to a stringer 1 foot by 4 inches. A bed of concrete 1 foot deep will be laid from out to out of the sheet-piling, and under the foundation-timbers.

The abutments to the dams will also be built of coursed masonry, rising about 6 feet, according to location, above the crest of the dams, and coped with ashlar 4 feet wide and 1½ feet thick, well bolted and clamped.

REACH-SLOPES.

It will be observed that in the schedule of dams and locks above given the level named has been carried through the respective reaches between the dams without allowance for surface-slope. In the profiles and cross-sections accompanying Mr. McElroy's report, and on which my calculations are based, the same has been done. He says, "It is best to estimate on the extreme height for dams and locks, although in practice the *remou*, or slope, will be duly determined and allowed for, in each case, before construction."

I have adopted this view on all the reaches between the dams, and have fixed the crest of the upper one (No. 11) at 116 feet above tide-water.

The level of the surface of the river at Fort Edward was determined by Mr. Hall in his recent survey, and found to be 118 feet above tide, which level I have assumed in connection with lock No. 12. The slope of the river, thus determined, between the assumed level at dam No. 11 and Fort Edward, a distance of 7.45 miles, is 2 feet.

Whenever the slope in the other reaches is accurately determined, the decrease in the lifts of the locks, and, in consequence, in the cost of their construction, can be ascertained.

LOCKS.

The crests of the adjacent dams will determine the lifts of the several locks. The highest lift proposed will be 17 feet; the lowest, 4 feet; averaging 10.54 feet each.

As a general rule, they are located with reference to facility of approach from the channel. A pier and guard wall, carried up to the same height as that of the lock-walls, will connect them with the shore. A pier-wall of similar height, and 10 feet in thickness, will be built between the back of the lock-wall and the end of the dam, making a working platform on top of 20 feet. The usual crib-arrangement is also provided for.

At dam No. 1, I propose to locate the lock at its west end, leaving the present sloop-lock at its east end untouched. There will be a better channel-approach to the new lock, and less trouble from ice, which, I am informed, always tends to the eastward above the sloop-lock. There would also be less rock-excavation required below the lock for the continuance of the channel to Albany.

The height of lock and guard walls of lock No. 1 will be carried up 8.75 feet above the new crest of the dam, to provide against freshets from the Mohawk River. That of the other lock and guard-walls will be 4 feet above the crests of the respective dams.

I have not been able to obtain the high-water mark at these locations; but as it is proposed to provide against freshets in the Hudson by means of a system of dams and reservoirs at its headwaters, I have assumed that by the time this improvement is made the provision against floods will be accomplished, and have therefore fixed the height of the locks accordingly.

CONSTRUCTION.

The details of construction, as well as of the dimensions of the locks, will be similar to those described under the head of "canal division."

The following diagram exhibits connectedly the height of dams, lengths of reaches, and lifts of locks from Troy to dam No. 11, and the ascertained slope of the river-surface thence to Fort Edward.

REGULATING-WEIRS.

No regulating-weirs will be required on this division; the spill of the several dams regulating the surface-levels.

CHANNEL.

The estimates herewith are based on an assumed channel of at least 200 feet in width at bottom, with 13 feet depth of water. The excavation in earth to be made by dredging; that in rock, by cutting a channel of the above-named width at bottom, with side slopes one-fourth to one. It is presumed that a large portion of this rock, which is "a slate, with sharp, deep fissures, and friable quality," can be removed by a dredging-machine with its bucket properly armed for the purpose. I have, however, "given the benefit of the doubt," and have estimated the cost of removal accordingly, inclusive of coffer-damming, if required.

PROPERTY-DAMAGES.

The amount of property-damages will be small. Protection-levees, aggregating 17,500 feet in length, will prevent serious overflows. The cost of land for this purpose is considered, together with that of the sites for the locks. This, with mill-claims, riparian damages, &c., it is estimated, will amount to $100,000.

BRIDGE-DRAWS.

An estimate is made for bridge-draws in the four wooden bridges now spanning the river, viz, at Saratoga Falls, Schuylerville, Stillwater, and Waterford.

The aggregate amount of estimates for the Hudson River division is $7,375,917.16. Estimates in detail are herewith submitted.

CONCLUSION.

In this my report on the "enlarged route from the Saint Lawrence River to Troy, on the Hudson River," made in compliance with your instructions of August last, I have confined myself strictly to the engineering features of the project. In connection therewith, I may remark that the route selected appears to be the natural connection between the termini referred to, viz, the Saint Lawrence River and Troy.

The Canada division requires but a short canal, through an almost level plateau, admirably adapted to the purpose. From thence to Troy, on the Hudson, the natural water-courses are followed, with but one intervening summit of only three and a half miles in length, and of remarkably low elevation. The water-supply will be ample, and the facilities for the construction of the proposed work abundant.

An "enlarged route" can, in my opinion, be obtained on this line at the estimated cost, through which vessels carrying 50,000 bushels of wheat, or other freight in proportion, can freely and safely navigate.

Maps, including a general map of the whole route, on a scale of two miles to 1 inch; maps of the canal and Hudson River division, on a scale of 500 feet to 1 inch, with general plan of lock, regulating-weir, &c., will also be submitted.

In connection with this improvement, I was directed by you in October last to make an examination and to submit a report and estimates on the cost of connecting the Hudson River, above the Troy dam, with Albany, via the Erie Canal; the latter to be enlarged to the dimensions of those of the proposed new canal.

In compliance therewith, I have the honor to submit the following supplementary report:

SUPPLEMENTARY REPORT.

In accordance with your instructions of October 23, 1874, I made a reconnaissance of the country between Cohoes and West Troy, for the purpose of determining upon the best line of connection between the Hudson River, above Troy dam, and the Erie Canal, and also extended my examination thence to Albany, with view to the enlargement of the said canal.

This reconnaissance, &c., satisfied me that the most feasible route could be made through the old Mohawk River and basin to a point near the weigh-lock at West Troy; thence connecting with the Erie Canal by means of a lock of such lift as would bring the level of the river up to that of the canal, and from thence widening the canal on

the east side to Albany. The results of a survey subsequently made under your direction by Mr. W. P. Judson, assistant engineer, confirmed my belief as to the feasibility of this route.

The estimates herewith submitted are based upon that survey for the Mohawk River division, and upon cross-sections and other measurements subsequently made by Mr. Judson, and on maps, &c., of the canal for the Erie Canal division.

I propose to consider the proposed line under two heads:

1. The Mohawk River division, extending from the Hudson River to the Erie Canal, at lock No. 1 (A).

2. The Erie Canal division, extending from lock No. 1 (A) to tide-water at Albany.

MOHAWK-RIVER DIVISION.

The mouth of the branch of the Mohawk River, which it is proposed to utilize in this connection, is one mile above the Troy dam, or dam No. 1 of the Hudson River division. The width of the old bed is ample for the purpose, but to render it navigable for vessels of 12-feet draught both heavy-rock-excavation and a large amount of dredging will be required.

The surface-level of that portion of the river now called the "Basin," is about 12 inches lower than the proposed level of the Hudson River above the Troy dam. Two side-cut locks at West Troy regulate the height of water in this basin, and to retain our proposed level it will be necessary to raise these lock-walls, together with the pier and vertical walls in connection, about 2 feet.

The channel between the Hudson River and the proposed lock No. 1 (A) is to be excavated to a depth of 13 feet below the assumed level (viz, 14.25 feet above tide-water) and to a width of 200 feet at bottom. In rock-cutting, the side slopes to be one-fourth to one. No other improvement will be required to render this channel navigable throughout its entire length.

Locks.

The level of the Erie Canal at the proposed point of connection being 24.5 feet, and that of the new channel 14.25 feet, a lock of 10.25 feet lift, and of the same dimensions in other respects as those already considered, will be required to connect the old Mohawk with the canal near the present weigh-lock. The details of construction will be the same as those of the locks of the canal division heretofore described.

Bridges.

Three swing or pivot bridges will be required on this division, viz, one single-track railroad-bridge at the crossing of the Rensselaer and Saratoga Railroad near the mouth of the Mohawk; one double-track railroad-bridge, at the crossing of the New York Central and the Rensselaer and Saratoga Railroads near the weigh-lock; and one highway-bridge at the site of the present dike. They will be all of the same span, viz, 190 feet, and with iron superstructures.

Property-damages.

The property-damages will be light on this division, most of the land to be taken belonging to the State of New York. They will be included under a general head.

ERIE-CANAL DIVISION.

The enlargement of the Erie Canal to Albany to the required dimensions, including the construction of the required bridges and culverts, constitutes the amount of work to be done on this division.

It is proposed to widen the canal on the east side by removing the berme-bank and by excavating the prism to the dimensions hereinbefore considered, viz, 100 feet wide on the bottom; slopes, two horizontal to one vertical; depth of water, 13 feet. Where vertical walls are substituted for slopes, the width on the bottom will be increased to 124 feet; the batter of the walls to be 2 inches to 1 foot.

Vertical walls are to be built from lock No. 1 (A) through West Troy and Port Schuyler to near the southern boundary of the latter; and from the foot of lock No. 2, near the upper end of the lumber-district, to lock No. 1, at Albany. The height of the former to be 4 feet above the surface-water of the canal; that of the latter, 2 feet above the same level; to conform to the general height of the ground or piers through the lumber-district.

Puddle-walls.—A puddle-wall is to be carried up with the embankments. It will be 3 feet in width, its top extending 1 foot above the surface of water in the canal, its bottom from 1 to 2 feet below the natural surface of the ground, depending on the character of the soil.

Locks.

Two lock are to be built, one near the present locks No. 2, of the Erie Canal, of 9.25 feet lift; the other near locks No. 1, at Albany, of 15.25 feet lift. Their dimensions and details of construction will be the same as those of lock No. 1, (A).

Lock No. 2 will be located near the east lock of the present double locks No. 2; its west chamber-wall to be about 20 feet from the wall of the west lock. Lock No. 1 will pass diagonally just below the present double locks at Albany, leaving both undisturbed.

Regulating-weirs.

It is proposed to use the side-cut locks at West Troy, the remaining lock, No. 2, and both of the old locks, No. 1, as regulating-weirs.

Bridges.

There are now twenty road-bridges, of various widths, spanning the Erie Canal on this division. These must be replaced by swing or pivot bridges, of lengths corresponding to the increased width of the enlarged canal.

The center piers are to be circular, and, with the abutments, will be constructed of coursed masonry. Their spans to be either 190 or 165 feet, depending on location. The superstructures in all cases will be iron.

Culverts.

Six new culverts, in place of those now in use, under the Erie, on this division, will be required. The lengths will be increased to meet the requirements of the enlarged prism; the water-ways to be of the same dimensions as in the present culverts.

They are to be constructed of coursed masonry, laid in hydraulic-cement mortar, backed with rubble. The foundations to be of 12 by 12 inches hemlock timbers, laid 1 foot apart, covered with a floor of pine plank 3 inches in thickness; the spaces between the wings and the water-way to have an additional floor of pine 2 inches thick, and laid so as to break joints.

Property-damages.

Although but a narrow strip of land will be taken in making this enlargement, the amount of property-damages will be heavy, from the fact that the line will cut many buildings in West Troy, Port Schuyler, &c., and will take off the ends of the piers in the Albany lumber district.

A personal inspection and valuation of each piece of property affected along the entire route having been recently made under your directions, I am enabled from the returns to submit a reliable estimate under this head.

The estimated cost of this division is	$1,670,754 58
The estimated cost of Mohawk River division is	568,210 64

Estimates in detail for both divisions are herewith presented.

Respectfully submitted.

C. A. FULLER,
Assistant Engineer.

Maj. J. M. WILSON,
United States Engineers.

CHAMPLAIN SHIP-CANAL ROUTE.

River division, 39.8 miles.—Troy to Fort Edward.—Locks.

Number of lock.	Excavation of earth.	Excavation of rock.	Embankment.	Puddling.	Lock-masonry.	Rubble masonry.	Concrete.	Floor-timbers.	Plank flooring.	Miter-sills.	Sheet-piling.
	Cu. yds.	*Cu. yds.*	*Cu. yds.*	*Cu. yds.*	*Cu. yds.*	*Cu. yds.*	*Cu. yds.*	*Ft. b. m.*	*Ft. b. m.*	*Ft. b. m.*	*Ft. b. m.*
1		9,275		1,399	8,862	609	1,263	114,000	105,585	7,764	
Pier-wall			3,852			3,439					
2		8,272		1,239	5,643	365	1,023	114,000	105,585	7,764	
			5,037			1,752					
3		6,106		1,359	5,424	352	1,010	114,000	105,585	7,764	
			6,600			3,921					
4		7,705		1,518	6,382	453	1,130	114,000	105,585	7,764	
			11,852			4,511					
5		7,805		1,060	4,883	302	963	114,000	105,585	7,764	
			6,250			2,828					
6		6,063		1,536	5,947	396	1,057	114,000	105,585	7,764	
			7,777			2,955					
7		9,234		1,738	7,770	594	1,236	114,000	105,585	7,764	
			5,111			3,665					
8		5,188		1,089	4,227	237	890	114,000	105,585	7,764	
			24,264			2,652					
9	301			1,837	4,692	285	1,057	171,156	105,585	7,764	8,880
			9,777			4,147					
10		6,781		1,608	6,262	446	1,103	114,000	105,585	7,764	
						5,264					
11		9,131		1,738	7,459	552	1,203	114,000	105,585	7,764	
			2,963			4,434					
Miter-sill walls						4,708					
Totals	301	75,560	83,483	16,123	67,551	48,887	11,935	1,311,156	1,161,435	85,404	8,880

CHAMPLAIN SHIP-CANAL ROUTE.

River division.—Estimate for locks.

Quantities and items.	Price.	Amount.	Total.
11 locks, bailing and draining .... per lock..	$5,000 00	$55,000 00	
301 cubic yards excavation of earth .... per cu. yd..	28	84 28	
75,560 cubic yards excavation of rock ....do.....	1 00	75,560 00	
83,483 cubic yards embankment ....do.....	28	23,375 24	
16,123 cubic yards puddling ....do.....	30	4,836 90	
67,551 cubic yards lock-masonry ....do.....	13 00	878,163 00	
48,887 cubic yards rubble-masonry ....do.....	8 00	391,096 00	
11,935 cubic yards concrete ....do.....	5 00	59,675 00	
1,311,156 feet, board-measure, floor-timbers .... per 1,000 ft..	20 00	26,223 12	
1,161,435 feet, board-measure, plank flooring ....do.....	45 00	52,264 58	
85,404 feet, board-measure, miter-sills ....do.....	60 00	5,124 24	
8,880 feet, board-measure, sheet-piling ....do.....	20 00	177 60	
39,611 pounds iron .... per pound..	12	4,753 32	
12,760 pounds spikes and nails ....do.....	06	765 60	
			$1,577,098 88
Equipment, &c.			
11 locks, crib-work .... per lock..	2,000 00	22,000 00	
11 locks, posts, &c ....do.....	300 00	3,300 00	
11 locks, lock-gates complete ....do.....	7,586 00	83,446 00	
11 locks, sulphur and sand ....do.....	60 00	660 00	
11 locks, painting gates ....do.....	100 00	1,100 00	
11 locks, houses ....do.....	2,000 00	22,000 00	
Cutting dam No. 10 for lock	....	2,860 00	
Cutting dam No. 1 for lock	....	2,000 00	
			137,366 00
			1,714,464 88

River division.—Dams.

No. of dam.	Length.	Ashlar.	Coursed masonry.	Concrete.	Embankment.	Pine.	Hemlock.	Maple.	Oak.	Loose stone.
	Feet.	*Cu. yds.*	*Cu. yds.*	*Cu. yds.*	*Cu. yds.*	*Ft. b. m.*	*Ft. b. m.*	*Ft. b. m.*	*Ft. b. m.*	*Cu. yds.*
2	660	424.47	3,122.00	784	88.37	131,318	67,914	27,165	45,259	8,296.00
3	567	365.97	2,840.50	686	352.29	187,708	66,055	26,422	44,037	8,143.60
4	210	140.97	1,444.00	278	574.22	50,364	26,051	10,420	17,337	3,632.50
B	700	449.47	2,248.00	779	237.39	98,861	51,135	20,454	34,090	4,855.50
5	700	449.47	2,560.50	805	580.72	120,388	62,265	24,906	41,501	6,195.88
B	320	210.47	1,243.50	376	342.59	55,030	28,464	11,386	18,976	2,832.13
6	1,000	638.47	4,886.50	1,200	516.76	225,040	116,400	46,560	77,600	14,437.50
7	220	147.47	1,880.50	291	285.96	64,183	33,198	13,279	22,132	5,565.82
Ba	330	216.97	1,125.50	362	409.54	46,606	24,106	9,642	16,072	2,137.89
Bb	280	185.47	1,300.00	363	208.19	47,562	26,670	14,668	17,780	2,926.33
Bc	280	185.47	974.00	310	1,024.94	39,544	20,454	8,182	13,636	1,807.15
8	550	355.47	1,793.00	595	163.01	77,666	40,178	16,071	26,795	3,663.15
9	550	355.47	4,039.00	1,854	340.10	151,684	131,258	31,383	52,305	12,517.02
11	670	430.97	3,167.00	783	138.56	133,290	68,943	27,577	45,962	8,367.20
Totals	7,037	4,556.58	32,624.00	9,466	5,262.64	1,369,244	763,091	288,115	473,482	85,277.61

River division.—Estimate for dams.

Quantities and items.	Price.	Amount.	Total.
4,557 cubic yards ashlar masonry .... per cu. yd..	$15 00	$68,355 00	
32,624 cubic yards coursed masonry ....do.....	10 00	326,240 00	
9,466 cubic yards concrete ....do.....	5 00	47,330 00	
5,263 cubic yards embankment ....do.....	28	1,473 64	
1,369,244 feet, board-measure, pine .... per 1,000 ft..	45 00	61,615 98	
763,091 feet, board-measure, hemlock ....do.....	20 00	15,261 82	
288,115 feet, board-measure, maple ....do.....	40 00	11,524 60	
473,482 feet, board-measure, oak ....do.....	60 00	28,408 92	
46,200 feet, board-measure, sheet-piling ....do.....	20 00	924 00	
85,278 cubic yards loose stone .... per cu. yd..	1 50	127,917 00	
184,728 pounds wrought-iron .... per pound..	12	22,167 36	
14 dams—sulphur and sand	150 00	2,100 00	
Raising and repairing dam No. 1	....	20,000 00	
			$733,318 32

River divisions.—Channel 39.8 *miles*

Section.	Length.	Rock excavation.	Dredging.
	Feet.	*Cu. yds.*	*Cu. yds.*
No. 1	34, 370	505, 392	132, 337
No. 2	44, 250	937, 929	18, 303
No. 3	66. 495	28, 700	182, 927
No. 4	65, 052	506, 135	311, 569
	210, 167	1, 978, 156	645, 136

Estimate.

Quantities and items.	Price.	Amount.	Total.
1,978,156 cubic yards excavation of rock .... per cu. yd..	$2 00	$3, 956, 312	
645,136 cubic yards dredging .... do.....	25	161, 284	
4 bridge-draws	10, 000 00	40, 000	
			$4, 157, 597

River division.—Levees and property-damages.

Quantities and items.	Price.	Amount.	Total.
61,568 cubic yards embankment (17,500 linear feet)........per cu. yd..	$0 28	$17, 239 04	
Property-damages, grading road, &c	....	82, 761 00	
			$100, 000 04

River division.—Summary of estimates.

Dams	$733, 318 32
Locks	1, 714, 464 88
Channel	4, 157, 596 00
Levees and property-damages	100, 000 04
	6, 705, 379 24
Engineering and contingencies 10 per cent	670, 537 92
	7, 375, 917 16

CANAL DIVISION 24.13 MILES.

Fort Edward to Whitehall.—Locks.

No. of lock.	Excavation of earth.	Excavation of rock.	Puddling.	Lock-masonry.	Rubble masonry.	Concrete.	Floor-timbers.	Plank flooring.	Miter-sills.	Sheet-piling.
	Cu. yds.	*Cu. yds.*	*Cu. yds.*	*Cu. yds*	*Cu. yds.*	*Cu. yds.*	*Ft. b. m.*	*Ft. b. m.*	*Ft. b. m.*	*Ft. b. m.*
12	26, 431	....	1, 678	7, 272	522	1, 175	171, 156	105, 585	7, 764	8, 880
13	18, 561	....	1, 608	6, 262	446	916	171, 156	105, 585	7, 764	8, 880
14	23, 464	....	1, 608	6, 262	446	917	171, 156	105, 585	7, 764	8, 880
15	8, 952	17, 562	639	8, 915	618	1, 263	114, 000	105, 585	7, 764	....
Pier and g. wall	....	....	....	....	2, 127	....	....	....	....	....
Miter-sill wall	....	....	....	....	2, 540	....	....	....	....	....
Totals	77, 408	17, 562	5, 533	28, 711	6, 699	4, 271	627, 468	422, 340	31, 056	26, 640

Canal division.—Estimate locks.

Quantities and items.	Price.	Amount.	Total.
4 locks, bailing and draining ....per lock..	$5,000 00	$20,000 00	
77,408 cubic yards excavation of earth ....per cu. yd..	28	21,674 24	
17,562 cubic yards excavation of rock ....do...	1 00	17,562 00	
5,533 cubic yards puddling ....do....	30	1,659 90	
28,711 cubic yards lock-masonry ....do....	13 00	373,243 00	
6,699 cubic yards rubble masonry ....do....	8 00	53,592 00	
4,271 cubic yards concrete ....do....	5 00	21,355 00	
627,468 feet, board-measure, floor-timbers ....per 1,000 ft..	20 00	12,549 36	
422,340 feet, board-measure, plank flooring .... do....	45 00	19,005 30	
31,056 feet, board-measure, miter-sills ....do....	60 00	1,863 36	
26,649 feet, board-measure, sheet-piling ....do...	20 00	532 80	
14 404 pounds iron ....per pound..	12	1,728 48	
4,640 pounds spikes and nails ....do....	06	278 40	
			$545,043 84
Equipment, &c.			
4 locks, crib-work ....per lock..	2,000 00	8,000 00	
4 locks, posts, &c ....do....	300 00	1,200 00	
4 locks, lock-gates complete ....do....	7,751 00	31,004 00	
4 locks, painting gates ....do....	100 00	400 00	
4 locks, sulphur and sand ....do....	60 00	240 00	
4 locks, houses ....do....	2,000 00	8,000 00	
			48,844 00
			593,887 84

Canal division.—Regulating-weir lock No. 12.

Quantities and items.	Price.	Amount.	Total.
4,327 cubic yards excavation of earth ....per cu. yd..	$0 28	$1,211 56	
193 cubic yards lining ....do....	50	96 50	
144 cubic yards puddling ....do....	30	43 20	
237 cubic yards vertical wall in cement ....do....	6 00	1,422 00	
320 cubic yards slope and pavement wall ....do....	2 00	640 00	
51 cubic yards ashlar masonry ....do....	15 00	765 00	
1,009 cubic yards coursed masonry ....do....	10 00	10,090 00	
929 cubic yards rubble masonry ....do...	8 00	7,432 00	
282 cubic yards concrete ....do ...	5 00	1,410 00	
4,200 feet, board-measure, sheet-piling ....per 1,000 ft..	20 00	84 00	
10,584 feet, board-measure, pine ....do....	45 00	476 28	
20,080 feet, board-measure, hemlock ....do....	20 00	401 60	
3,979 pounds wrought iron ....per pound..	12	477 48	
8,351 pounds of cast iron ....do....	08	668 08	
650 pounds spikes and nails ....do....	06	39 00	
			$25,256 70

Canal division.—Regulating-weir lock No. 13.

Quantities and items.	Price.	Amount.	Total.
2,667 cubic yards excavation of earth ....per cu. yd..	$0 28	$746 76	
193 cubic yards lining ....do....	50	96 50	
137 cubic yards puddling ....do...	30	41 10	
237 cubic yards vertical wall in cement ....do....	6 00	1,422 00	
320 cubic yards slope and pavement wall ....do...	2 00	640 00	
78 cubic yards ashlar-masonry ....do....	15 00	1,170 00	
721 cubic yards coursed masonry ....do....	10 00	7,210 00	
58 cubic yards concrete ....do....	5 00	290 00	
4,200 feet, board-measure, sheet-piling ....per 1,000 ft..	20 00	84 00	
10,584 feet board-measure, pine ....do....	45 00	476 28	
20 080 feet, board-measure, hemlock ....do....	20 00	401 60	
3,630 pounds wrought iron ....per pound..	12	435 60	
8,316 pounds cast iron ....do...	08	665 28	
650 pounds spikes and nails ....do....	06	39 00	
			$13,718 12

Canal division.—Regulating-weir lock No. 14.

Quantities and items.	Price.	Amount.	Total.
2,870 cubic yards excavation of earth .... per cu. yd..	$0 28	$803 60	
245 cubic yards lining .... do....	50	122 50	
137 cubic yards puddling .... do....	30	41 10	
237 cubic yards vertical wall in cement .... do....	6 00	1,422 00	
420 cubic yards slope and pavement wall .... do....	2 00	840 00	
45 cubic yards ashlar masonry .... do....	15 00	675 00	
625 cubic yards coursed masonry .... do....	10 00	6,250 00	
23 cubic yards rubble masonry .... do....	8 00	184 00	
874 cubic yards culvert-masonry .... do....	9 00	7,866 00	
453 cubic yards concrete .... do....	5 00	2,265 00	
4,200 feet, board-measure, sheet-piling .... per 1,000 ft..	20 00	84 00	
10,584 feet, board-measure, pine .... do....	45 00	476 28	
20,080 feet, board-measure, hemlock .... do....	20 00	401 60	
3,630 pounds wrought iron .... per pound..	12	435 60	
8,316 pounds cast iron .... do....	08	665 28	
650 pounds spikes and nails .... do....	06	39 00	
			$22,570 96

Canal division.—Prism.

Quantities and items.	Price.	Amount.	Total.
5,739,792 cubic yards excavation of earth .... per cu. yd..	$0 28	$1,607,141 76	
290,418 cubic yards excavation of rock .... do....	1 00	290,418 00	
4,015 cubic yards vertical wall in cement .... do....	6 00	24,090 00	
139,688 cubic yards puddling .... do....	30	41,906 40	
70,805 cubic yards lining .... do....	50	35,402 50	
			$1,998,958 66

Canal division.—Regulating-weirs.

Regulating-weir lock No. 12	$25,256 70	
Regulating-weir lock No. 13	13,718 12	
Regulating-weir lock No. 14	22,570 96	
		$61,545 78

CHAMPLAIN SHIP-CANAL ROUTE.

Canal division, estimate for dam, 125 *feet* (*Whitehall*).

Quantities and items.	Price.	Amount.	Total.
84 cubic yards ashlar masonry .... per cu. yd..	$15 00	$1,260 00	
435 cubic yards coursed masonry .... do....	10 00	4,350 00	
74 cubic yards concrete masonry .... do....	5 00	370 00	
14,138 feet, board-measure, pine .... per 1,000 ft..	45 00	636 21	
7,312 feet, board-measure, hemlock .... do....	20 00	146 24	
2,925 feet, board-measure, maple .... do....	40 00	117 00	
4,875 feet, board-measure, oak .... do....	60 00	292 50	
1,492 cubic yards loose stone .... per cu. yd..	1 50	2,238 00	
3,580 pounds wrought iron .... per pound..	12	429 60	
Sulphur and sand	....	100 00	
			$9,939 55

Canal division, swing bridges, 190 feet span, 20 feet roadway.

No.	Location.	Excavation, earth.	Excavation, rock.	Ashlar-masonry.	Abutment-masonry.	Concrete.	Pine.	Hemlock.	Piling.
	Highway.	*Cu. yds.*	*Cu. yds.*	*Cu. yds.*	*Cu. yds.*	*Cu. yds.*	*Ft. b. m.*	*Ft. b. m.*	*Lin. ft.*
1	Whitehall	....	171	35	619	80	....	....	....
2	......do	....	171	35	582	80	....	....	....
3	......do	171	....	35	510	40	7,700	10,680	1,568
4	Comstock's	171	....	35	570	40	7,700	10,680	1,568
5	Lime-Works	....	171	35	510	80	....	....	....
6	Fort Ann	....	171	35	676	80	....	....	....
7	......do	171	....	35	744	40	7,700	10,680	1,568
8	Smith's Basin	171	....	35	510	40	7,700	10,680	1,568
9	Station 1073	171	....	35	510	40	7,700	10,680	1,568
10	Fort Edward	171	....	35	695	40	7,700	10,680	1,568
11	......do	171	....	35	570	40	7,700	10,680	1,568
12	......do	171	....	35	621	40	7,700	10,680	1,568
13	Ch. Canal, 75 feet span	....	171	18	247	80	....	....	....
	Railroad.								
14	Whitehall	171	....	35	510	40	7,700	10,680	1,568
15	Smith's Basin	171	....	35	510	40	7,700	10,680	1,568
	Total	1,710	855	508	8,384	800	77,000	106,800	15,680

Canal division, estimate for bridges, 190 feet span.

Quantities and items.	Price.	Amount.	Total.
1,710 cubic yards excavation of earth....per cu. yd..	$0 28	$478 80	
855 cubic yards excavation of rock....do....	1 00	855 00	
508 cubic yards ashlar-masonry....do....	15 00	7,620 00	
8,384 cubic yards abutment-masonry....do....	13 00	108,992 00	
800 cubic yards concrete....do...	5 00	4,000 00	
77,000 feet, board-measure, pine....per 1,000 ft..	45 00	3,465 00	
106.800 feet, board-measure, hemlock....do....	20 00	2,136 00	
15 680 linear feet piles....per lin. ft..	30	4,704 00	
7,650 pounds iron (spikes and nails)....per lb..	06	459 00	
			$132,709 80
Superstructures.			
2 railroad-bridges, 190 feet span....	16,150 00	32,300 00	
12 highway-bridge, 190 feet span....	14,440 00	173,280 00	
1 tow-path and road bridge, 75 feet span....	....	2,475 00	
			208,055 00
			340,764 80

Estimate Fort Edward dam and feeder.

Quantities and items.	Price.	Amount.	Total.
Dam.			
11,363 cubic yards coursed masonry....per cu. yd..	$10 00	$113,630 00	
575 cubic yards ashlar-masonry....do....	15 00	8,625 00	
37,366 cubic yards loose stone....do....	1 00	37,366 00	
1,382 cubic yards concrete....do....	5 00	6,910 00	
30,744 pounds wrought-iron....per lb..	12	3,689 28	
118,600 feet, board-measure, pine timber....per 1,000 ft..	45 00	5,337 00	
43,200 feet, board-measure, oak timber....do....	60 00	2,592 00	
Sulphur, sand, &c....	....	200 00	
			$178,349 28
Weir.			
1 regulating weir, 10 feet lift....	....	....	11,321 37

Estimate Fort Edward dam and feeder—Continued.

Quantities and items.	Price.	Amount.	Total.
Feeder.			
6,602 cubic yards excavation ... per cu. yd..	$0 28	$1,845 56	
510 cubic yards embankment ... do....	28	142 80	
9,429 cubic yards vertical wall ... do....	6 00	56,574 00	
295 cubic yards concrete ... do....	5 00	1,475 00	
			$60,037 36
Summary-estimate.			
Dam	....	178,349 28	
Weir	....	11,321 37	
Feeder	....	60,037 36	
Repairs of guard-lock, &c	....	6,000 00	
Lock-house	....	2,000 00	
Property-damages	....	25,000 00	
			282,708 00
Add 10 per cent. for engineering and contingencies	....	....	28,270 80
			310,978 80

Canal division.—Property-damages.

Quantities and items.	Price.	Amount.	Total.
40.85 acres	$500 00	$20,425 00	
22.96 acres	300 00	6,888 00	
520.18 acres	100 00	52,018 00	
Removing buildings, Fort Edward	....	1,500 00	
Property, Whitehall	....	65,000 00	
			$145,831 00

Canal division.—Summary of estimates.

Dam	$9,939 55
Locks	593,887 84
Prism	1,998,958 66
Regulating-weirs	61,545 78
Bridges	340,764 80
Fort Edward dam and feeder (less 10 per cent. contingencies)	282,708 00
Property-damages	145,831 00
	3,433,635 63
Engineering and contingencies, 10 per cent	343,363 56
	3,776,999 19

General summary of estimates.

River division:		
Dams	$733,318 32	
Locks	1,714,464 88	
Channel	4,157,596 00	
Levees and property-damages	100,000 04	
		$6,705,379 24
Engineering and contingencies, 10 per cent		670,537 92
		7,375,917 16
Canal division:		
Dam	9,939 55	
Locks	593,887 84	
Prism	1,998,958 66	
Regulating-weirs	61,545 78	
Bridges	340,764 80	
Fort Edward dam and feeder	282,708 00	
Property-damages	145,831 00	
	3,433,635 63	
Engineering and contingencies, 10 per cent	343,363 56	
		3,776,999 19
		11,152,916 35

SHIP-CANAL FROM TROY TO ALBANY.

Locks from Hudson River, via Old Mohawk and Erie Canal, to Albany.

No. of lock.	Earth-excavation.	Puddling.	Lock-masonry.	Rubble-masonry.	Concrete.	Floor-timbers.	Plank-flooring.	Miter-sills.	Miter-sill walls.	Iron.	Spikes and nails.	Sheet-piling.
	C. yds.	*C. yds.*	*C. yds.*	*C. yds.*	*C. yds.*	*Ft. b. m.*	*Ft. b. m.*	*Ft. b. m.*	*C. yds*	*P'ds.*	*P'ds.*	*Ft. b. m.*
No. 1, A..........	22, 720	1, 542	5, 947	396	1, 057	171, 156	105, 585	7, 764	428	3, 601	1, 060	8, 880
No. 1, Erie.......	35, 000	1, 827	8, 915	618	1, 057	171, 156	105, 585	7, 764	428	3, 601	1, 060	8, 880
No. 2, Erie.......	13, 712	1, 485	5, 643	365	1, 057	171, 156	105, 585	7, 764	428	3, 601	1, 060	8, 880
Totals.....	71, 432	4, 854	20, 505	1, 379	3, 171	513, 468	316, 755	23, 292	1, 284	10, 803	3, 180	26, 640

NOTE.—Lock No. 1, A, between Old Mohawk basin and Erie Canal, at West Troy weigh-lock.
Lock No. 1, Erie, at Albany.
Lock No. 2, Erie, between Albany and West Troy.

Locks from Hudson River, via Old Mohawk and Erie Canal, to Albany.

Quantities and items.	Price.	Amount.	Total.
3 locks, bailing and draining .... per lock..	$5,000 00	$15,000 00	
71,432 cubic yards excavation of earth .... per cu. yard..	28	20,000 96	
4,854 cubic yards puddling .... do....	30	1,456 20	
20,505 cubic yards lock-masonry .... do....	13 00	266,565 00	
1,379 cubic yards rubble-masonry .... do....	8 00	11,032 00	
3,171 cubic yards concrete .... do....	5 00	15,855 00	
513,468 feet, board-measure, floor-timbers .... per 1,000 feet..	20 00	10,269 36	
316,755 feet, board-measure, plank flooring .... do....	45 00	14,253 97	
23,292 feet, board-measure, miter-sills .... do....	60 00	1,397 52	
1,284 cubic yards, miter-sill walls .... per cu. yard..	8 00	10,272 00	
10,803 pounds iron .... per pound..	12	1,296 36	
3,180 pounds spikes and nails .... do....	06	190 80	
26,640 feet, board-measure, sheet-piling .... per 1,000 feet..	20 00	532 80	
			$368,121 97
Equipments, &c.:			
3 locks, crib-work .... per lock....	2,000 00	6,000 00	
3 locks, posts, &c .... do ...	300 00	900 00	
3 locks, lock-gates .... do....	7,856 00	23,568 00	
3 locks, sulphur and sand .... do....	100 00	300 00	
3 locks, painting gates .... do ...	60 00	180 00	
3 houses .... per house..	2,000 00	6,000 00	
			36,948 00
Total for three locks	....	....	405,069 97

Lock No. 1, A, Mohawk River division	$115,641 80
Locks Nos. 1 and 2, Erie Canal division	289,428 17
Total	405,069 97

Culverts from Hudson River, via Old Mohawk and Erie Canal, to Albany, Erie Canal division.

Station.	Structure.	Masonry.				Lumber.			Iron.
		Arch.	Coursed.	Rubble.	Total.	Hemlock.	Pine.	Total.	
		Cub. feet.	*Cub. feet.*	*Cub. feet.*	*Cub. feet.*	*Feet b. m.*	*Feet b. m.*	*Feet b. m.*	*Lbs.*
169+75	Single arch...	4, 180	2, 550	5, 960	12, 690	16, 170	6, 132	22, 302	38
251+20	Double arch..	3, 675	8, 817	15, 708	28, 200	28, 050	15, 216	43, 266	123
266+75	Box	....	4, 410	....	4, 410	11, 760	6, 090	17, 850	26
311+47*	Single arch...	1, 648	2, 838	1, 008	5, 494	11, 430	5, 688	17, 118	41
349+65	...do.........	2, 205	6, 222	2, 415	10, 842	23, 210	8, 850	32, 060	64
419+65	3-box.........	....	18, 216	3, 048	21, 264	47, 822	46, 522	94, 344	217
		11, 708	43, 053	28, 139	482, 900	138, 442	88, 498	226, 940	509

* 3,070 cubic yards.

Estimate for six culverts.

Quantities and items.	Price.	Amount.	Total.
3,070 cubic yards masonry ....per cu. yard..	$9 00	$27,630 00	
188,442 feet, board-measure, hemlock ....per 1,000 feet..	20 00	3,768 84	
88,498 feet, board-measure, pine ....do....	45 00	3,982 41	
509 pounds iron ....per pound..	06	30 54	
			$35,411 79

Bridges from Hudson River, via Old Mohawk and Erie Canal, to Albany.

No.	Width.	Span.	Excavation.	Ashlar-masonry.	Pier and abutment masonry.	Concrete.	Pine.	Hemlock.	Iron.
Railroad.				*Cu. yds*	*Yds.*	*Yds.*	*Ft. b. m.*	*Ft. b. m.*	*Lbs.*
1	Single	190	......	30	410.47	21	....	....	....
2	Double	190	233	86	1,573.50	45	10,500	13,708	570
Road.									
1	20	190	204	35	510	40	7,700	10,680	510
2	30	165	319	60	981	45	10,500	13,708	570
3	30	165	319	60	981	45	10,500	13,708	570
4	30	165	319	60	981	45	10,500	13,708	570
5	50	165	479	121	1,834	73	16,373	24,192	960
6	30	165	319	60	981	45	10,500	13,708	570
7	30	165	319	60	981	45	10,500	13,708	570
8	30	165	319	60	981	45	10,500	13,708	570
9	20	165	204	35	510	40	7,700	10,680	510
10	30	165	319	60	981	45	10,500	13,708	570
11	20	165	204	35	510	40	7,700	10,680	510
12	20	165	204	35	510	40	7,700	10,680	510
13	20	190	204	35	510	40	7,700	10,680	510
14	20	190	204	35	510	40	7,700	10,680	510
15	20	190	204	35	510	40	7,700	10,680	510
16	20	190	204	35	510	40	7,700	10,680	510
17	20	190	204	35	510	40	7,700	10,680	510
18	20	165	204	35	510	40	7,700	10,680	510
19	30	165	319	60	981	45	10,500	13,708	570
20	40	165	409	80	1,191	56	11,885	18,516	740
21	20	190	204	35	510	40	7,700	10,680	510
Total	......	......	5,917	1,182	18,466.97	995	207,458	283,560	12,440

Bridges from Hudson River, via Old Mohawk and Erie Canal, to Albany.

Quantities and items.	Price.	Amount.	Total.
5,917 cubic yards excavation ....per cu. yd..	$0 28	$1,656 76	
1,182 cubic yards ashlar-masonry ....do....	15 00	17,730 00	
18,467 cubic yards pier and abutment masonry ....do....	13 00	240,071 00	
995 cubic yards concrete ....do....	5 00	4,975 00	
207,458 feet, board measure, pine ....per 1,000 ft..	45 00	9,335 61	
283,560 feet, board-measure, hemlock ....do...	20 00	5,671 20	
12,440 pounds iron spikes and nails ....per lb..	06	746 40	
			$280,185 97
Superstructures.			
1 double-track railroad-bridge, 190 feet span	24,700 00	24,700 00	
1 single-track railroad-bridge, 190 feet span	16,150 00	16,150 00	
7 road-bridges, 190 feet span, 20 feet wide	14,440 00	101,080 00	
4 road-bridges, 165 feet span, 20 feet wide	10,560 00	42,240 00	
8 road-bridges, 165 feet span, 30 feet wide	12,870 00	102,960 00	
1 road-bridge, 165 feet span, 40 feet wide	15,015 00	15,015 00	
1 road-bridge, 165 feet span, 50 feet wide	16,995 00	16,995 00	
			319,140 00
			599,325 97

Mohawk River division, three bridges	$91,995 13
Erie Canal division, twenty bridges	507,330 84
	599,325 97

Estimated cost of adding 2 feet in height to two locks and pier-walls, West Troy side-cut.

Quantities and items.	Price.	Amount.
303 cubic yards lock-masonry .... per cu. yd..	$13 00	$3,939 00
379 cubic yards vertical wall .... do ...	5 00	1,895 00
1,768 feet, board-measure, oak timber .... per 1,000 ft..	60 00	106 08
20 pounds spikes .... per lb .	06	1 20
36 pounds bolts	12	4 32
2,093 cubic yards lining .... per cu. yd..	50	1,046 50
2,093 cubic yards embankment .... do ...	28	586 04
Snubbing-posts, &c	......	300 00
Total	......	7,878 14

From Hudson River, via Old Mohawk and Erie Canal, to Albany.—Property-damages.

Quantities and items.	Price.	Amount.
Land and buildings, West Troy	....	$190,700 00
Land and buildings, Port Schuyler	....	61,200 00
Land and buildings, Troy road	....	21,000 00
Land and buildings, Albany	....	175,000 00
22.5 acres of land, Hudson River to Albany .... per acre..	$300	6,750 00
Total	....	454,550 00

From Hudson River, via Old Mohawk River and Erie Canal, to Albany, Mohawk River division, 2.25 miles.

Quantities and items.	Price.	Amount.
35,932 cubic yards excavation, earth .... per cu. yd..	$0 28	$10,060 96
277,677 cubic yards excavation, rock .... do....	1 00	277,677 00
291,343 cubic yards excavation, dredging .... do....	25	72,835 75
Lock No. 1 (A), 10.25 feet lift	....	115,641 80
Single-track railroad-bridge	....	22,041 50
Double-track railroad-bridge	....	47,516 80
Road-bridge	....	22,436 83
Total	....	568,210 64

From Hudson River, via Old Mohawk and Erie Canal, to Albany, Erie Canal division, 6.06 *miles.*

ESTIMATE.

Quantities and items.	Price.	Amount.
1,166,463 cubic yards excavation of earth .... per cu. yd..	$0 28	$326,609 64
149,895 cubic yards excavation of rock .... do....	1 00	149,895 00
66,413 cubic yards vertical wall, in cement .... do....	5 00	332,065 00
420 cubic yards slope-wall .... do....	2 00	840 00
29,577 cubic yards lining .... do....	50	14,788 50
22,025 cubic yards puddling .... do....	30	6,607 50
2 locks	....	289,428 17
6 culverts	....	35,411 79
20 bridges	....	507,330 84
Raising locks, &c., West Troy side-cut	....	7,778 14
Total	....	1,670,754 58

GENERAL SUMMARY.

	Amount.
Mohawk River division, 2.25 miles	$568,210 64
Erie Canal division, 6.06 miles	1,670,754 58
Property-damages	454,650 00
Engineering and contingencies, 10 per cent	269,361 52
Total, 8.31 miles	2,962,976 74

CC 9.

FIRST SUBDIVISION OF THE CENTRAL TRANSPORTATION-ROUTE.

REPORT OF MAJOR W. E. MERRILL, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Cincinnati, Ohio, February 25, 1875.

GENERAL: In your letter of June 30, 1874, you direct me to submit a report on the following through transportation route recommended for examination by the Senate Committee on Transportation, viz, "the radical improvement of the Ohio River from Cairo to Pittsburgh, so as to give 6 or 7 feet of navigation at low water." In accordance with these instructions I have the honor to submit the following report.

The subject of the radical improvement of the Ohio River has been so often discussed in official reports that it will only be necessary in this connection to give the conclusions set forth in these reports. My predecessor in charge of the improvement of the Ohio, Mr. W. Milnor Roberts, civil engineer, in his last report on the river, dated April 21, 1870, and printed as Ex. Doc. No. 72, House of Representatives, Forty-first Congress, third session, recommended the ordinary slack-water system, with the addition of what he called "freshet-chutes," to be opened and closed by the floating ponton devised by the Hon. F. R. Brunot, of Pittsburgh, generally known as Brunot's hydraulic gate. The details of these chutes he did not attempt to elaborate.

The Board of Engineers appointed to make a report on the radical improvement of the Ohio by hydraulic gates and movable dams, consisting of Major Weitzel and myself, submitted a report, dated January 31, 1874 (printed as Ex. Doc. No. 127, House of Representatives, Forty-third Congress, first session), in which, after giving full descriptions of all the various apparatus in use in France, Germany, England, and India, they finally concluded that, before deciding absolutely upon any method of improvement, it would be desirable to test the Brunot gate on the Monongahela.

In addition they expressed the opinion that, should this gate work satisfactorily, it might be more advantageous to use it in connection with permanent dams than to adopt the French practice of movable dams.

The Board thus substantially agreed with Mr. W. Milnor Roberts.

Since that time I have continued my studies in this matter, and have finally concluded that the French system of movable dams is the best that can be adopted. I have therefore abandoned the contingent opinion which, as a member of the Board, I gave in favor of permanent dams with Brunot's gate and sluice. This final opinion is given in my last annual report on the improvement of the Ohio River, printed in the Report of the Chief of Engineers for 1874.

My reasons for this change are briefly as follows:

1. The Brunot gate itself may not operate satisfactorily; on this point we have no positive information, as the trial which the Board recommended was not made for lack of an appropriation for this purpose. Something, however, can be learned from the test made in France of the Krantz ponton, which in many respects is similar to the Brunot ponton or gate. On this matter my information is unfortunately vague, the substance of it being that I have received private advices from a distinguished French engineer, that the Krantz system, which, as stated

in the Board report, was on trial on the Seine below Paris, did not work satisfactorily. It is possible, however, that the trouble may have arisen from the points in which it differs from Brunot's gates, and not from those in which the two agree; I therefore do not lay much stress on this objection.

2. The Brunot gate, if used as proposed, requires the addition of a long inclined plane above and below the gate, so as, if possible, to avoid the wave at the entrance into the pass and the waves at the foot, where connection is made with the lower pool. There seems good reason to fear that these waves might prove dangerous to coal-fleets. In any event these inclined planes must be quite costly. It is apparently impossible to avoid them, as the construction of the Brunot ponton is such that when the pass is open the ponton is dropped down into a chamber beneath it. The depth of this chamber must be a little more than the depth of the ponton. The bottom of this chamber cannot be much, if at all, below the bed of the river, as otherwise it might become impossible to keep it clear of sedimentary deposits. Allowing one foot of clearance below the ponton, we find that the greatest depth to which the latter can be lowered is one-half a foot less than half the vertical distance between the comb of the dam and the bed of the river. Assuming a difference of level between the two pools of 6 feet, and a depth of 6 feet at the head of the lower pool, we find that the ponton when down cannot be lower than $\frac{12}{2}-\frac{1}{2}=5\frac{1}{2}$ feet below the crest of the dam, or $6\frac{1}{2}$ feet above the bottom of the river. Assuming that the opening of the pass will not materially lower the level of the upper pool, which would be the case if, as assumed in the Board report, the pass were opened in low water only long enough to let a fleet through, we would have a difference of level of 6 feet to be overcome. The inclined plane could not have a steeper slope than 1 in 100, and it would be better to give it as little as 1 foot in 200. We thus see that the lower inclined plane could not be less than from 600 to 1,200 feet in length. The length of the upper inclined plane, by which the water is gradually brought to the pass, would not be great. It should be long enough to prevent any wave at the head. Probably a base of 100 feet, with a suitable widening of the upward prolongations of the side-walls, would accomplish the purpose.

The steepest natural slopes on the Ohio are found when the river is at its lowest stage. At Horsetail, five miles below Pittsburgh, there is a fall of 1 foot in 461 feet; at Deadman's Island, fourteen miles below, a fall of 1 foot in 513; at the Twin Islands, eighty-five miles below, 1 foot in 781; and at the Trap, eleven miles below, 1 foot in 800. All of these slopes are much more gentle than the gentlest suggested for the lower inclined plane of the chute.

Narrow sluices for passage through permanent dams were in general use in France prior to the invention of the present system of movable dams. In order to throw as much light as possible on this vexed question of inclined planes I have made the following translations in regard to sluices from the best French authorities on this subject. The one that follows is from Minard's *Navigation des Rivières et des Canaux.*

The width of sluices in the narrowest part generally exceeds that of a boat by from 15 inches to 2 feet on each side. It ought to be even greater for sluices whose side-walls are parallel, in order to facilitate the entrance of boats. [The plates show the width of a large sluice to be about 40 feet.]

Sluices have been made for a fall of from 2 to 4 feet. The latter are dangerous to navigation and to the solidity of the works. It is necessary to wait before passing boats through until the discharge has greatly lessened the fall.

The floors of sluices are from 23 to 33 feet in length. The side-walls may be longer.

It is advisable that they should not be parallel, and that the pass should widen out at each end, in order to guide the boat and to prevent it from striking violently against the walls. It is likewise advisable to terminate the side-walls by wood work extensions which will deaden the shock.

By considering the different circumstances of the passage of boats through sluices, we can determine how to arrange the dimensions of the latter.

When a boat descends freely through a sluice it experiences a more or less violent commotion when it strikes the gyratory counter-current which is usually found at the foot of a rapid, and in which lightly-laden boats may even remain in equilibrium, pushed from behind and held back in front.

Thus in January, 1834, a large empty abandoned boat was carried in a flood of the Corréze on to the top of the weir of the Brives dam. It was precipitated to the foot of the cataract, where it stopped; it remained there more than 15 hours, making short movements backward and forward, and battering down the masonry of the dam.

Also in November, 1834, having learned from an engineer that a skiff could remain, as it were, in suspense on the rapid of Saint-Maur-sur Marne sluice, I went there with him; we ascended the current, which flowed through the sluice, in a sail-boat, completing our trip through the sluice by having the boat hauled into the cataract; on getting there we found that the boat, whose sail was lowered, remained almost at rest, its bow in the current, and its stern supported by the wave of the counter-current. An occasional stroke of the oar kept the boat in line with the current and prevented it from moving sideways. We allowed it to remain in this position for an hour, and we had much difficulty in extricating ourselves from it.

With an instrument hurriedly made, I found that the thickness of the layer of counter-current was only about 3 inches; the variations of the current made it very difficult to make this measurement; the whirl was 13 inches in diameter.

The total fall was 14 inches; the foot of the cataract was 11 inches lower than the level of the lower pool; the velocity of the current, at the position of the boat, was at least 7½ feet per second; the skiff, holding three persons, drew 7 inches amidships. Fig. 46 [not copied] shows the course followed by a floating body thrown in above the rapid.

The counter-current at the lower ends of sluices is analogous to that which we have examined in the over-falls of weirs; but the nearness of the side-walls modifies it somewhat. This effect is more or less moderated as the fall is lessened.

When a boat already on an incline corresponding to the surface of the water meets the whirl, which is from 1 foot to 1½ feet in height, it is checked in front and strongly pushed in the rear; the result of these opposing forces is to incline it still more, and to cause the bow to plunge. It is then desirable that the floor should be as low and as short as possible, and it is even well to make an artificial excavation at the lower end.

On the other hand, it is desirable that the side-walls should be long enough to hold the water, and to reduce the slope by lengthening it. They may, therefore, be prolonged beyond the floor. It then becomes indispensable to build them on piles, the principal effect of the fall being a great scouring at the foot.

In fact the removal and replacing of the beams or needles, the hauling of a boat up through the sluice, and the waiting until the current has moderated, will necessitate the opening of the sluice for three or four hours, during which time a violent current acts on the bottom. Therefore, the prolongations of the side-walls beyond the floor are as much exposed to undermining as the piers of a bridge. It is, therefore necessary, unless the bottom is of rock, to surround them with deeply-driven piles and sheeting-piles.

This tendency to scouring is very great; it would be useless to oppose it. Extensions of the floor, besides injuring boats, would, sooner or later, be carried away.

The sole of the pass is not vertically undermined in the beginning; the soil, even when it is moderately firm, is at first cut away on a very steep slope near the pass, and then on a gentle slope; so that the maximum of depth is generally found at from 25 to 40 feet from the end of the sole; but afterward the scouring action travels backward to just under the sole, in consequence of a whirl with horizontal axis, which uplifts the wooden platform with which these soles are sometimes terminated. It is in consequence of this eddy that we sometimes find that in artificial deepenings made with a vertical fall just beyond the sole, the current has brought back a part of the excavated material and has formed a slope beginning at the lower end of the sole.

The depth of the scour, and the distance to which it extends, vary with the fall and the nature of the bottom, whose hardness finally yields in the course of time. Do we not see very hard granite rocks wasted and worn away under the natural falls of rivers? It seems, in fact, that the deepening ought to increase until, in consequence of the excavation, there will be such great masses of water to be put in motion as to use up a part of the quantity of action caused by the fall; in a word, the regimen of the cataract must become established, like that of a less rapid current.

In the *Cours de Constructions* of MM. Sganzin and Reibell are some remarks on the sluices formerly so largely used in France before the

invention of movable dams, from which I extract the following paragraphs as pertinent to the question before us:

The size of sluices is limited by the method employed in closing them, which is very variable; there are sluices varying in width from 13 to 26, and even to 43, feet, depending upon the dimensions of the boats, the violence of the floods, &c.

The width of opening of sluices for the passage of floods, and for the transit of rafts or loose logs, varies from 10 to 26 feet in sluices now existing.

Their soles are generally placed on a level with the bed of the river above the dam, and they connect with the bed below the dam by a slope. In this way sluices for discharge can also be used for the passage of boats. The bottoms of these sluices in soils that will wash, should be protected by a sole with a guard-sole below, as has been indicated for passes always open.

The width of these passes depends on the maximum widths of the boats. * * * The sluices used for navigation have their side-walls prolonged much farther down stream, in order to guide the boats and especially to make more gentle the curvilinear slope of double curvature which connects the upper pool with the lower.

To still more lessen this slope, the sluice is opened a quarter of an hour before the passage of boats in either direction, although this often causes an injurious lowering of the water in the upper pool. It has been recommended that the side-walls should have unequal length down stream, in order to diminish the boils and waves which are formed where the sluice-water meets that which has fallen over the dam.

The construction of the sole of a navigable sluice is surrounded with difficulties; if it is much prolonged on a straight slope downward, there is reason to fear that the boat in its oscillations will strike it; if it is made very short, there may result serious scours at the foot when the river-bottom is not firm.

Although the sluices above described differ in many particulars from the inclined planes proposed for use in connection with the Brunot ponton, they yet are sufficiently alike to enable us to get some valuable information from the experience obtained by their use during many centuries. Navigable sluices were used on the Yonne as far back as the reign of Louis IX (1226–1270), as an ordinance of this king is extant forbidding the construction of anything in the bed of this river that might hinder navigation. In February, 1415, Charles VI ordered that all sluices should be 24 feet in width, which decree was reaffirmed in 1520, 1598, 1669, and 1673. In 1720 the number of dams with sluices on the Upper Yonne was twenty-five, and on the Lower Yonne there were ten. These sluices were gradually widened and improved, but the greatest change was inaugurated in 1835, when the first Poirée needle-dam was built. By this invention the width of sluices was increased to 72 feet, thus changing them into what are now known as navigable passes. In 1860, a still further advance was made by the substitution of Chanoine wickets for needle-dams. This substitution is now complete, and represents the greatest advance thus far made in movable dams.

The Chanoine system, which this brief history shows to have been the culmination of the experience of centuries, is the one which I desire to put into operation on the Ohio.

I conclude from the descriptions quoted above that there might be serious trouble in the use of inclined planes, from the dangerous scour likely to take place at the foot of these planes, and also from the waves and whirls which would endanger the safety of barges. The difficulties which were found on small rivers, and with small bodies of water, would probably be increased with larger rivers and wider sluices.

The only French systems that use the power of the stream for working the movable parts are the Girard, the Desfontaines, and the Krantz. None of these can be used for a pass whose sole is on a level with the bottom of the river, and in this respect they are like the Brunot system. It therefore follows that, as far as our present knowledge extends, the use of sluices with gates that can be maneuvered rapidly, both for opening and closing, likewise necessitates the use of an inclined plane. It

is proper to add that the use of inclined planes for chutes or passes in weirs is unknown in France; the three French systems mentioned above being only used on weirs to control the levels of the pools by regulating the discharge of the river at the site of the dam.

3. The use of permanent dams or weirs equipped with the Brunot gate would compel all up-stream navigation to go through the locks. Very high floods, in which it might be possible to go over the dams, occur so seldom in the upper part of the river that they need not be considered. On the other hand, if the inclined-plane system should prove to work well, it may be possible to maintain a continuous down-stream navigation through the chute at all times. This would be a decided advantage, if attainable. As it is necessary, in order to make an exact comparison between the proposed Brunot system and others, to assume a precise case for comparison, I have taken the dam at or near McKee's Rocks, being the proposed site for the first dam on the Ohio River.

The French system requires all navigation both up and down stream to pass through the locks, when there is less than 6 feet of natural navigation, but at all other times the river is entirely unobstructed. The main question therefore is, Which of the two systems will give most help to navigation?

I am constrained to believe that the towing interest would prefer to have the river kept as much as possible in its natural state, and that they would consider it hazardous to be always under the necessity of running a chute or going through the lock when descending the river. Experience has shown that for dams of 6 feet lift, such as are proposed in the Ohio, a rise of 15 feet in the natural river is required in order to give a depth of 7 feet over the combs. This depth would allow the safe passage of boats drawing 6 feet of water.

Confining ourselves for the present to the upper part of the river, where alone the actual work of construction is recommended at present, we find from the records of the Pittsburgh gauge, as kept during the seventeen years between 1854 and 1871 (see Report of Chief of Engineers for 1871, page 399), that the average duration of a stage of 15 feet or more is but ten days per annum. This is very irregularly distributed as follows:

	Days.
January	1.1
February	1.1
March	2.4
April	2.4
May	0.8
June	0.5
July	0
August	0
September	0.2
October	0.1
November	0.4
December	0.9
Total for the year	9.9

This shows that no dependence can be placed on passing over the dams. The times when such a feat is possible are so short in themselves, and they are so irregularly distributed through the year, that the assistance which navigation would receive from this source is too slight for serious consideration. We may, therefore, come to the conclusion that, in the vicinity of the head of the Ohio, the permanent-dam system would require all ascending boats to go through the locks and all descending boats to go through the chute.

On the French plan, the river is entirely open whenever there is 6 feet and over on the marks. Examining the record previously quoted, we find the following average durations of a stage of 6 feet or more:

	Days.
January	16.9
February	16.3
March	26.0
April	26.4
May	19.7
June	9.4
July	5.2
August	4.5
September	5.2
October	5.0
November	10.2
December	18.5
Total for the year	163.3

We thus find that on the French plan we will have an open river, with 6 feet or more of water for navigation, for nine-twentieths of the year. During the other eleven-twentieths, navigation in both directions must pass through the locks. Therefore I conclude that the French system would better provide for navigation on the Ohio than the system of permanent dams. The same course of investigation, however, would prove the exact opposite on small rivers, that seldom have a sufficiency of water for a natural navigation.

4. The effect of permanent dams is always to cause a shoaling above the dams. As a general rule this shoaling is insignificant in amount, and does not hinder navigation. It is equally true, however, that in rivers heavily laden with sand, such as those in the East Indies, the pools above dams always fill up even with the combs of the dams. I therefore conclude, that in the Ohio River above the falls, permanent dams would not cause any injurious shoaling, but that below the falls they probably would do so. As this shoaling always takes place in high water, these effects would not occur with movable dams, as at that stage they would be out of the way. Any small deposits that might occur while the dams were up would be swept away when they were down.

5. A great advantage of movable over permanent dams arises from the fact that the great strains on dams, and the great dangers of injury by undermining or by turning the abutments, occur during floods, at which time the movable dams have ceased to be dams. They are thus perfectly safe from the most serious source of danger to all constructions placed in the bed of a river.

These reasons, and the example of the French, who are the best authorities in the world on such subjects, have caused me to change my half-formed opinion into one decidedly in favor of movable dams.

NAVIGABLE PASS AND WEIR.

The next question to be decided is the width of the navigable pass. I know of no serious objection to making this pass as wide as the navigation interests may desire, but as 400 feet is considered sufficient to allow a safe passage between bridge-piers, I have considered it unnecessary to give a greater width to the pass. The reasons why the whole river is not made a navigable pass are as follows: The pass-wickets are very large and heavy, and are not easy to handle. It is therefore desir-

able to reduce their number as much as possible. This can be done by making a part of the dam of smaller wickets on a foundation raised above the bed of the river. This method of construction likewise gives greater facilities in managing small rises, which if allowed to discharge by overflow alone would raise the level of the upper pool too high, and yet are not sufficient to justify the opening of the pass. By dropping some of the weir-wickets, which are easily managed, the rise can be passed without difficulty and the wickets can readily be raised again. On the other hand, when the whole dam is down the weir partly obstructs the water-way, and may make too great a current through the pass if the latter be too narrow. The widest French passes on the Upper Seine are from 180 to 214 feet. They are generally a little more than 40 per cent. of the width of the river. At the selected site for the first dam on the Ohio the width of the river, exclusive of the area required for the lock and the abutment, is 1,200 feet. If we give the pass a width of 40 per cent. of the whole width of the river, it would be 480 feet wide. This width, however, seems greater than is necessary. The widths of coal-tows seldom exceed 125 feet (or a front of five barges), and as the width between the channel-piers of the Steubenville bridge is but 300 feet, of the Bellaire bridge but 322 feet, of the Parkersburg bridge but 350 feet, and of the Newport and Cincinnati bridge 400 feet, the last-named width seems ample for a navigable pass. In order, however, to provide against undue contraction of the water-way, the half of the weir adjacent to the navigable pass should have its sole at the level of the low-water line, the sole of the other half of the weir being at the usual level of two feet above low water. This is the method recommended by the latest French authorities for very wide rivers, and for those for which the usual width of navigable pass causes too great a velocity through the pass when the dam is down. On the highest level of the weir it will probably be very advantageous to use Desfontaines's drum-wickets, or the Brunot ponton. The question of choice between the two can, however, be left for future study, as in any event the dams cannot be built until the locks are finished. In making the estimate which accompanies this report, I have thought it best to assume that the whole dam will be composed of Chanoine wickets, as these will undoubtedly accomplish our object. If the other systems should be thought better for the highest level of the weir, the estimate will still be substantially correct.

In my last annual report I only estimated for a width of navigable pass of 250 feet. Since then I have concluded, after consulting with those interested in Ohio River navigation, and studying the first location for a dam, the surveys for which were then in progress, that it would be better to widen the pass to 400 feet.

LOCK.

Experience in France on navigations similar to what is proposed for the Ohio, shows that it is greatly to the advantage of navigators for the locks to be large enough to pass ascending or descending fleets at one lockage. An average coal-fleet has ten barges (130 by 25 feet), one fuel-flat (100 by 22 feet), and one steamboat (230 by 48 feet). The barges could pass two abreast if the locks were 52 feet wide, three abreast if they were 78 feet, and four abreast if they were 103 feet. The first-named width, however, is too narrow for the usual packet steamboats, which require from 60 to 80 feet, and the last-named is too wide to be closed by the ordinary lock-gate. The width of lock must therefore

necessarily be 78 feet in order to accommodate all classes of traffic in the best manner.

To hold such a fleet as I have described above will necessitate an available length (from the lower side of the miter-wall of the upper gates to the recesses of the lower gates) of 628 feet. The length between hollow quoins will therefore be 680 feet, and the total length of the river-wall, from head to foot, will 770 feet.

This length may seem excessive, but the advantage of passing a fleet at one lockage is very great, and the increase of cost is not in proportion to the length of the lock. The most expensive parts of a lock are the gates and the masonry around them, and they cost the same in all locks of the same width and lift, regardless of their length. The difference between a short and a long lock, of the same width and lift, is only the cost of the extra length of chamber-wall, and this is the cheapest masonry about the lock. The fleets on the Seine are somewhat smaller than those on the Ohio, although their larger barges have almost exactly the same dimensions as Ohio coal-barges. To pass one of these fleets at a single lockage, the lock-chambers on the Upper Seine have a width of 40 feet, and an available length of from 591 to 615 feet.

In my last annual report, I recommended that the lock should be divided into two parts by a pair of middle gates, in order that single steamboats and small tows might be accommodated without using so large an amount of water as would be required to fill the whole lock.

After the detailed plans of the lock were prepared, I found that the extra cost of these gates, and of the additional culverts that must go with them, would not be justified by the saving in the consumption of water. The low-water discharge of the Ohio was found by Mr. Roberts, my predecessor, to be 1,600 cubic feet per second. This is sufficient to fill the whole lock in 3½ minutes. As the lock would not be used oftener than once in 15 minutes for single steamboats, or once in 20 minutes for fleets, we evidently have an abundance of water to spare even in the lowest stages. The leakage through the dam can be reduced as much as may be desired by the usual expedient of laying planks over the intervals between the wickets.

I have not estimated for a double lock, as I think that the large single one proposed will answer every purpose. It will be just as well adapted to the needs of commerce when several boats are moving in the same direction, but it will not be so useful when boats moving in opposite directions meet at a lock. To balance this disadvantage we have the greater facilities which it offers to large tows, and, besides, it should be borne in mind that when navigation is naturally most active the dam is down, the river is entirely open to navigation, and the lock is not needed. On the Seine it has not been found necessary to double any of the locks. The usual lift of the lock, when both pools are at their normal levels, will be 6 feet, but the walls have been calculated to resist the greatest pressure that can come on them when the lock is either full or emptied for repairs.

ESTIMATE.

One river-lock, with lift of 6 feet, 6 feet on lower miter-sill, 628 feet of available length, and 78 feet of width in the clear.

	Cut-stone masonry.	Coursed rubble.	Uncoursed rubble.	Price.	Cost.
	Cub. yds.	*Cub. yds.*	*Cub. yds.*		
River-wall, face	2,434			$15 00	$36,510
coping	312			15 00	4,680
backing			2,470	6 50	16,055
Land-wall, face	1,172			15 00	17,580
coping	238			15 00	3,570
backing			2,818	6 50	18,317
Miter-walls	230			15 00	3,450
Upper wing-wall, face		60		8 50	510
coping	20			15 00	300
backing			120	6 50	780
Lower wing-wall, face		40		8 50	340
coping	15			15 00	225
backing			110	6 50	715
Coffer-dam and pumping					6,000
Rock-excavation, 10,000 cubic yards				2 00	20,000
Lock-gates, 4 leaves				4,000 00	16,000
Wickets with apparatus, 20				200 00	4,000
Manœuvering needle-dam at head of lock				1,250 00	1,250
House for lock and dam tenders				5,000 00	5,000
Engineering—engineer and assistant 2 years				4,000 00	8,000
Total					163,282
Contingencies, 10 per cent					16,328
Total for one lock on rock-foundation					179,610

This estimate is $20,000 less than the rough estimate ($200,000) which I made in my last annual report. A large portion of this saving is due to the suppression of the middle gates, with their attendant culverts, and enlargement of the side-walls.

At the site selected for the first dam, the river has a rock-bed, but as we approach the left bank this bank is overlain by a layer of gravel and sand. The estimates which follow will therefore only apply to cases of similar foundations.

As stated before, the pass is closed by Chanoine wickets having 12 feet vertical height above the sill of the pass, and placed at a distance apart, measured from center to center of wicket, of 3.61 feet. These are the dimensions used at the Port-à-l'Anglais dam, and though they appear awkward when given in English feet, it has been thought best to preserve them for the present. There will be no difficulty in slightly changing them when the actual work of construction is begun. The interval between wickets is 0.33 of a foot, or 4 inches.

All the coffer-dams, for which estimates are submitted, are built to a height of 8 feet above the low-water line, so that they will not be submerged until there is 10 feet of water in the channel.

Navigable pass giving an opening of 400 feet and having its sill 2 feet below low water.

COFFER-DAM, PER RUNNING FOOT.

Material.	Price.	Quantity.	Cost.
String-pieces	$35 per 1,000 feet	85 feet	$2 98
Sheeting-planks	do	150 feet	5 25
Two-inch round-iron ties	3 cents per pound	210 lbs	6 30
Gravel	50 cts. per cubic yard	6 yards	3 00
Labor			5 00
Cost of one running foot of coffer-dam			22 53

PUMPING, PER RUNNING FOOT.

To make an approximation of the cost of this service, it is necessary to make some assumptions. At the best, this expense must, from the nature of the case, be indeterminate.

We will assume that work can only be attempted during a period of five months, say from June 15 to November 15, that being the usual period of lowest water; that it will take two such seasons to complete the dam; and that the yearly depreciation of the pumping-apparatus will be 10 per cent., and its yearly repairs the same.

A 10-inch centrifugal pump, with 15-horse-power steam-engine, will cost	$1,500 00
A flat-boat for carrying it	800 00
Total cost of plant	2,300 00
Yearly cost of plant, depreciation, and repairs, 20 per cent	460 00
Cost of plant for two years	920 00
One engineer, ten months, at $90 per month	900 00
Two deck-hands, ten months, at $90 per month	900 00
Coal, three hundred bushels per month for ten months, at ten cents per bushel	300 00
Cost of pumping for two seasons, or for building 1,200 feet of dam	3,020 00
Cost of pumping, per running foot of dam	2 50
As this work is subject to extraordinary accidents by floods, it would be better to put it at	3 00

Foundation per running foot.

Material.	Price.	Quantity.	Cost.
Rock-excavation per cubic yd.	$2 00	4.5 yards.	$9 00
Cut-stone masonry do.	15 00	1.13 yards.	16 95
Rubble do.	6 50	1.0 yards.	6 50
Sills per 1,000 feet.	45 00	34.0 feet.	1 57
Labor			5 00
Cost of one running foot of foundation			39 02

Appurtenances of the sole per one wicket and per running foot.

Name of part.	No.	Material.	Quantity.	Price.	Cost.
Heurter and slide	1	Wrought iron	480 lbs	10 cts. per lb	$48 00
Tripping-rod	1	do	98 lbs	10 cts. per lb	9 80
Guides	2	do	42 lbs	10 cts. per lb	4 20
Roller	1	Bronze	26 lbs	40 cts. per lb	10 40
Cost of appurtenances per wicket					72 40
Cost of appurtenances per running foot					20 55
Labor					5 00
Total per running foot					25 55

Wicket, total cost and cost per running foot.

Name of part.	No.	Material.	Quantity.	Price.	Cost.
Horse	1	Wrought iron	450 lbs	10 cts. per lb	$45 00
Anchoring-rods	2	do	133 lbs	10 cts. per lb	13 30
Anchoring-disk	1	Cast iron	80 lbs	7 cts. per lb	5 60
Prop	1	Wrought iron	600 lbs	10 cts. per lb	60 00
Journal-boxes	4	Cast iron	220 lbs	7 cts. per lb	14 50
Bolts and nuts	30	Wrought iron	330 lbs	5 cts. per lb	16 50
Panel	1	Lumber	409 feet	$50 per 1,000 ft.	20 45
Cost of wicket					175 35
Cost of wicket per running foot					48 57

LOW WEIR.

Sill at level of low water.

The coffer-dam required will be identical with the one employed for the navigable pass, consequently the same estimate will hold good in this case.

Foundation, per running foot.

Material.	Price.	Quantity.	Cost.
Concrete	$5.00 per cubic yard	0.75 cubic yard	$3 75
Gravel	50 per cubic yard	0.80 cubic yard	40
Cut-stone	15.00 per cubic yard	1 cubic yard	15 00
Boards—inner sheeting for concrete frame.	30.00 per 1,000 feet	12 feet	36
Uprights for same	39.00 per 1,000 feet	5 feet	15
Sills	45.00 per 1,000 feet	34 feet	1 57
Riprap	1.60 per cubic yard	1.22 cubic yard	1 95
Labor			5 00
Cost of one running foot of foundation			28 18

The costs of the appurtenances of the sole and of the wickets will be five-sixths of the costs of the similar parts of the navigable pass. They will therefore be as follows:

Appurtenances of the sole, per running foot $21 29
Wickets, per running foot 40 47

HIGH WEIR.

Sill two feet above low water. Coffer-dam same as for the low weir. Foundation per running foot.

Material.	Price.	Quantity.	Cost
Concrete	$5.00 per cubic yard	1.25 cubic yard	$6 25
Gravel	50 per cubic yard	2 cubic yards	1 00
Cut-stone	15.00 per cubic yard	1 cubic yard	15 00
Sills	45.00 per 1,000 feet	34 feet	1 57
Riprap	1.60 per cubic yard	3 cubic yards	4 80
Labor			5 00
Cost of one running foot of foundation			33 62

The costs of the appurtenances of the sole and of the wickets will be two-thirds of the costs of the similar parts belonging to the navigable pass. They will therefore be:

Appurtenances of the sole, per running foot $17 03
Wicket, per running foot 32 38

PIERS.

As the length of a pier is the same as the width of the floor of the pass, the cost of its foundations per running foot, measured in the direction of the length of the dam, will be the same as the cost of the length of foundation of the pass. The width of a pier being 11.48 feet, it will only be necessary to multiply the cost of the foundation of the pass per running foot by 11.48 to obtain the cost of the foundation of a pier.

Cost of foundation of one pier 71.55×11.48	$821 39
115.02 cubic yards of cut-stone masonry, at $15	1,725 30
101.56 cubic yards of rubble-masonry, at $6.50	660 14
Maneuvering capstan for tripping-rod	1,000 00
Cost of one pier	4,206 83

ABUTMENT.

The abutment is located at the shore-end of the weir.

Foundation of abutment.

Material.	Price.	Quantity.	Cost.
Piles, 10' long, driven	$4.20 each	12 piles	$50 40
Sheeting-piles, 10' long, driven	3.70 each	125 sheeting-piles	462 50
Concrete	5.00 per yard	30 yards	150 00
Cost of foundation of abutment			662 90

Superstructure of abutment and accessory works.

Material.	Price.	Quantity.	Cost.
Cut-stone masonry	$15 per yard	103.5 yards	$1,552 50
Concrete backing	5 per yard	87.17 yards	430 85
Capstan and gearing		1 capstan and gearing	1,000 00
Grading bank, paving, riprap, &c			5,000 00
Cost of superstructure of abutment and accessory works			7,983 35

SUMMARY.

Having thus determined the cost in detail of each part of the dam, we will now bring them together in order to determine the cost in the aggregate.

Navigable pass.

Coffer-dam, per running foot	$22 53
Pumping, per running foot	3 00
Foundation, per running foot	39 02
Appurtenances of the sole, per running foot	25 55
Wicket, per running foot	48 57
Total per running foot	138 67
Cost for 400 feet of width	55,468 00

Low weir.

Coffer-dam, per running foot	$22 53
Pumping, per running foot	3 00
Foundation, per running foot	28 18
Appurtenances of the sole, per running foot	21 29
Wicket, per running foot	40 47
Total per running foot	115 47
Cost of 400 feet of width	46,188 00

High weir.

Coffer-dam, per running foot	$22 53
Pumping, per running foot	3 00
Foundation, per running foot	33 62
Appurtenances of the sole, per running foot	17 03
Wicket, per running foot	32 38
Total per running foot	108 56
Cost for 400 feet of width	43,424 00

Abutment.

Foundation	$662 90
Superstructure	7,983 35
Cost of abutment	8,646 25

Gathering together the costs thus determined for each part of the dam and neglecting quantities less than one dollar, we have the following:

Navigable pass	$55,468
Pier	4,207
Low weir	46,188
Pier	4,207
High weir	43,424
Abutment	8,646
Engineering and superintendence two years, at $6,000	12,000
Total	174,140
Contingencies, 20 per cent	34,828
Total estimate of cost of dam	208,968

I have added 20 per cent. for contingencies, because work like this in the bed of a large river, liable to sudden and high rises, is subject to injuries and accidents which cannot possibly be foreseen, nor can they be covered by an estimate except in this way.

The site selected for the first dam on the Ohio has a local peculiarity which makes the works more costly than they would be at many other places. The profile of the river compels the location of the dam with one end abutting on Davis's Island. This necessitates the closing of the channel back of this island. This channel is 420 feet in width, and the dam must be built up to the same level as the normal pool, which is 10 feet above low-water. It is proposed to build a dam of piles and cofferwork, the mass of the dam being riprap stone, paved on top, and supported by a long apron of riprap interspersed with piles.

The down-stream slope of the top of the dam will be one on three. The banks above and below the dam will be graded and paved, and will have a bank of riprap at the foot of the slope for protection against undermining. The method of construction thus indicated is in accordance with the best French methods.

DAM BEHIND DAVIS'S ISLAND.

Cost of dam per running foot.

One row sheet-piling, 10 feet long, at $4.75 per running foot, driven	$4 75
40 feet, board-measure, caps, at $35	1 40
28 feet, board-measure, longitudinal stringers, at $35	98
53½ feet, board-measure, transverse-ties, at $35	1 87
3 piles, driven, at $5	15 00
3.7 cubic yards stone-paving, at $3.50	12 95
12 cubic yards riprap, at $2	24 00
2 cubic yards gravel, at 40 cents	80
Labor	5 00
Total per running foot	66 75
Cost for dam 420 feet in length	28,035 00

Bank protection above and below dam.

400 piles, at $5	$2,000 00	
925 cubic yards paving, at $2.50	2,312 50	
500 cubic yards grading bank, at 20 cents	100 00	
200 cubic yards riprap, at $2	400 00	
Total		4,812 50
Total cost of dam, including bank-protection		32,847 50

TOTAL COST OF DAM NO. 1, ON THE OHIO RIVER, INCLUDING ALL ACCESSORY WORKS.

Lock	$179,610
Dam	208,968
Auxiliary dam behind Davis's Island	32,847
	421,425

The estimates on a lock and dam thus far given presuppose a rock foundation. In case we should be compelled to build on gravel the preceding estimates must be increased. It then becomes imperative to give the lock an artificial bottom or floor of concrete, to found the pass and wiers on similar beds of concrete, and to guard against injurious filtrations by lines of sheet-piling.

This method of construction is expensive, but it seems to be the only one that gives thoroughly reliable results. On the Monongahela wooden floors are used, but they are frequently out of repair, and their weakness is constantly endangering the safety of the locks. The following extracts from Minard's *Navigation des Rivières et des Canaux* show the best foreign practice in such cases:

Soil incompressible, but liable to scour.

Sands, gravel, &c.—Found directly on the soil, and give the floors a thickness of from 2 to 6½ feet, depending upon the lift, the width of the lock, and the tenacity of the masonry; oppose subterranean filtrations by cross-walls of beton or masonry descending lower at the head and foot of the lock and under the miter-sills than the general foundations, or by carefully driven rows of matched sheeting-piles under the whole width of the lock; make the floor thicker under the miter-sills and under the lower gate chambers. Make an apron below the lock whose thickness decreases as it recedes from the lock, and whose total length depends on the lift and the resistance of the soil.

Sheeting-piles are very efficacious for intercepting subterranean communication. I have seen locks a hundred years old on the Picardy Canal which still worked passably, although the lock-chamber no longer had a floor, because the rows of sheeting-piles under the miter-sills were in good condition.

To have the rows of sheeting-piles well joined, it is necessary to use the system which was formerly followed and which is yet in use among the Dutch.

The piles are so arranged as to be capped by two parallel stringers, leaving between them an interval equal to the thickness of the sheeting-piles; the latter can then be driven by continuous panels and by slight successive penetrations along the whole length of the row, so that they reach their ultimate penetration without losing contact, and mutually sustaining each other; which, as is well known, is the advantage of driving by panels.

On the other hand, when they are driven by the ordinary method of first driving piles held between two rows of stringers, and then sheeting-piles in the interval between the clamps, the piles obtain isolated holes, independent in direction one of the other, and it is difficult to form a connection between them and the intermediate sheeting-piles.

Ties that are parallel to the length of a lock are the cause of dangerous filtrations, because when the earth settles which was placed under them it leaves a void which cannot be filled, and which establishes a continuous communication from the water above the lock to that below it, whilst similar voids under the caps are interrupted at each pile.

If, as often happens in these kinds of soil, the springs are very abundant, after having excavated until the pumping becomes too costly, the trench for the foundation should be finished by dredging. The bottom should be graded to suit the drainage; the sides of the excavation should be slightly raised; then drainage-wells should be dug in the lowest parts; after which the whole should be covered by a bed of from 1 to 2 feet of beton, so as to have a kind of large, flat, impermeable canal, in which pumping can be done after the mortar has set.

Beton, placed on the soil, chokes or diminishes the bottom springs, and makes pumping much less expensive. I found in a similar case that ten Archimedean screws were sufficient to lay bare an excavation covered with 16 inches of beton, while seventeen screws had not succeeded in getting water lower than 2½ feet above the bottom of this excavation.

If the foundations are much below the level of the springs, it will be necessary, after

dredging, to drive an inclosure of piles and sheeting-piles at the feet of the main slopes of the excavation, which must be somewhat widened; then a layer of beton, of from 2 to 3 feet in thickness, must be poured into the inclosed space; next, by means of scaffolds resting on the heads of the piles of the inclosure, whose top must be above the level of the springs, vertical or inclined posts must be planted in the beton, which will serve to support panels, so as to make a second interior inclosure, forming with the first one a perimetrical coffer-work, which should be filled with beton up to the level of the springs, supporting it on the exterior by earth-filling. We will thus have a coffer-dam, inside of which we can pump out after the mortar has set. The posts and panels will then be removed, and the masonry will be built. The masses of beton in the coffer-dam, cut in steps if the posts were inclined, will form part of the side-walls and of the lift-wall. At the lower end of the lock they must be removed to below the surface, in order to open communication with the lock, unless from motives of economy this part of the coffer-dam was made of clay, which can more readily be removed.

If there is danger of cracking the beton by driving in the posts, their feet can be buttressed by long timbers extending from one side of the coffer-dam to the other.

The interior posts ought to be somewhat inclined; if they are much inclined, considerably less beton is required; but that part which fills the acute angle of the coffer-work can only get there by flowing down a slope, and at this part all the milk of the beton (*laitance*) will be accumulated. This has but a very moderate consistence. and may give rise to accidents, which can be avoided by using vertical or slightly-inclined panels.

I have given the above translation on account of its intrinsic value, and because it is contained in a very valuable treatise (Minard's *Navigation des Rivières et des Canaux*) which is now out of print. This book was recommended to me by a distinguished French engineer (M. Malézieux) as the best authority on such work, and by good fortune I succeeded in securing a copy. I ought to add that "beton" and "concrete" are synonymous terms.

I think that I am perfectly safe in saying that every lock on the Ohio will be founded on rock, gravel, or sand.

Having estimated for a lock on rock foundation, it remains to determine what modification will be required in the estimates for sand and gravel foundations.

The great difficulty occurs in the lock-chamber. Although by using sheet-piling we may greatly reduce the percolation of water through the soil under the lock, it is impossible to stop it entirely. The effect of this under-current of water is to cause an upward pressure on the floor of the lock whenever the chamber is empty. This upward pressure must be met by dead-weight, or by weight aided by tenacity. If we use nothing but concrete, it will resist partly by its weight (due allowance being made for reduction of weight by immersion), and partly by its construction as a monolith, with its ends firmly held under the side-walls.

If we fill the area with piles and a less amount of concrete in the spaces between the piles, we will then have a resistance due to the weight of the concrete in water, increased by the resistance of the piles to extraction.

Lastly, we may use masonry built in what is known as plate-bands, or reversed arches, with an infinite radius for the intrados. The key-stone is wedge-shape, with its widest face lowest; the other voussoirs have their sides inclining toward the key, and their under-widths are slightly greater than their widths at the intrados. The plate-band may, therefore, be considered as the extreme case of a flat arch. It may be built on a foundation of concrete, or on a wooden platform, thus making two additional methods.

All the plans described above require the same expenditure for coffer-dam and for the rows of sheet-piling, designed to prevent subterranean filtration. The cost of these works will, therefore, be estimated before going into the details of the floor.

COFFER-DAM.

This will be built of two rows of piles and sheeting-piles, 8 feet apart, and the space between the rows will be filled with gravel. The outside sheeting-piles will be 3 inches thick and 12 feet long; the inner ones being 2 inches by 10 feet long. The latter will be driven by hand.

Coffer-dam per running foot.

Material.	Price.	Quantity.	Cost.
Piles, 18′ long	\$5.40 per pile, driven	⅕	\$1 09
Outer sheeting-piles	\$3 per pile, driven	1⅕	3 60
Inner sheeting-piles	\$40 per 1,000 feet	20 feet, board-measure	80
Wales	\$35 per 1,000 feet	12 feet, board-measure	42
Gravel	50 cents per cubic yard	2⅓ cubic yards	1 17
Labor			2 00
Total			9 07
Cost of 1,040 feet of coffer-dam			9,434 80

Sheeting-piles.

The sheet-piling, to prevent filtration, should extend along the whole length of the river-wall, across the head, across the foot, under the lower miter-sill, and on the prolongation of the line of the dam. Its total length will be 1,136 feet.

Sheet-piling per running foot.

Material.	Price.	Quantity.	Cost.
Piles, 14 feet long	\$4.68	$\frac{1}{10}$	\$0 47
Sheeting-piles	\$4.80 per pile, driven	1⅕	5 76
Wales	\$35 per 1,000 feet	10.67 feet, board-measure	37
Labor			1 00
Total			7 60
Cost of 1,136 feet of sheeting-piles			8,633 60

Pumping.

The price of pumping will be taken at the price previously determined, viz, \$3,020 for the two seasons that will probably be required for constructing the lock.

FLOORS OF LOCK-CHAMBERS.

Concrete only.

To determine the necessary thickness of the concrete, De Lagrené (*Navigation Intérieure*, vol. iii, p. 77) gives the following formula:

$$e = \frac{-l^2 + l\sqrt{l^2 + 2h\pi}}{\pi}$$

in which—

e = thickness of concrete in meters;
l = half-width of lock in meters = 12;
h = lift of lock in meters = 2;
π = safe tensile strain on concrete = 5 tons per square meter.

Substituting these values in the formula, we get—

$$e = \frac{-144 + 12\sqrt{144 + 2 \times 2 \times 5}}{5} = 1.9 \text{ meters} = 6\tfrac{1}{4} \text{ feet.}$$

This result is a large one, and, as experience has shown (Minard, *Navigation des Rivières et des Canaux*, p. 184) that the under pressure is always less than the theoretical head, I have estimated on a uniform thickness of 6 feet.

17,333 cubic yards concrete, at $5	$86,665
22,000 cubic yards gravel excavation, at 30 cents	6,600
	93,265

Piles and platform with concrete.

The usual practice in France is to put the concrete on top of the platform, while the contrary is the practice in this country. It seems to me that where concrete is used under the platform voids may occur under the bottom of the lock by settlement or otherwise, and that under these circumstances the concrete would probably become detached from the piles and the under surface of the platform, with which its bond is necessarily weak, and would fall into these voids. If this should happen, the platform would have to withstand the under pressure without any help from the concrete. This would not occur, however, where the concrete was placed above the platform, and for that reason I prefer the French practice.

In the following estimate the supporting-piles are placed 7 feet apart over the whole area occupied by the chamber, and 3½ feet apart under the walls, and 3 feet of concrete is placed on the platform. The maximum upward pull on each pile under the chamber, allowing for the maximum under pressure due to the head, is calculated at 5 tons, but experience has shown that this is much greater than will be found in practice. The friction on the sides of the piles will be ample to withstand this upward pressure even at its maximum.

Lock-foundation piles and concrete.

Material.	Price.	Quantity.	Cost.
Piles, 12 feet long, driven	$425	2 576	$10,948
Caps, 10 by 12	$35 per 1,000	135,000	4,725
Iron straps, spikes, and bolts	6 cents	70,000 pounds	4,200
4-inch floor-planks	$35 per 1,000	312,000	10,920
Transverse floor-binders, 6 by 8	$35 per 1,000	34,320 feet, board-measure.	1,201
8-inch spikes	4 cents	18,000 pounds	720
Labor capping piles	50 cents	2,576	1,288
Labor laying floor	50 cents	780 linear feet	390
Labor laying floor-binders	$2	110	220
Concrete	$5	8,667 cubic yards	43,335
Riprap	$1.50	2 500 cubic yards	3,750
Gravel excavation	30 cents	22,000 cubic yards	6,600
Gravel filling	50 cents	2,500	1,250
Total			89,547

Plate-bands of masonry resting on concrete and on piles and platform.

The thickness of the plate-bands will be taken at 2½ feet, resting on 2 feet of concrete in the first case, and on piles and platform in the second. In the first case, therefore, there will be a substitution of 2½ feet of plate-band masonry for 4 feet of concrete. The volumes of the two will therefore be in the proportion of 5 to 8. Equality in cost would require that the price of a cubic yard of masonry should be one and three-fifths greater than that of a cubic yard of concrete. But as this masonry must be of cut stone, it is evident that its cost would more than exceed this limit. This method of construction, therefore, need not be examined in detail. The same remarks apply still more strongly to the case of plate-bands on piles and platform, as in this case the 2½ feet of masonry only replaces 3 feet of concrete.

Where concrete is used, with or without piles and platform, the bed of concrete must extend under the side walls, replacing a portion of the masonry. This will make a reduction in cost of about $5,000 in lock-masonry.

Summing up the results thus far obtained, we get the following:

Lock on gravel with concrete floor.

Coffer-dam		$9,433
Sheeting-piles		8,634
Pumping		3,020
Foundation and floor		93,265
Lock, as per estimate for rock foundation		179,610
Total		293,962
Deduct from estimate on rock foundation, coffer-dam, and pumping	$6,000	
Rock excavation	20,000	
Saving on lock-walls	5,000	
		31,000
		262,962
Add 10 per cent. for contingencies		26,296
Total cost of lock		289,258

Lock on gravel, with piles, platform, and concrete.

Coffer dam	$9,433
Sheeting-piles	8,634
Pumping	3,020
Foundation and floor	89,547
Lock, as per first estimate, with deductions as indictated above	148,610
	259,244
Add 10 per cent. for contingencies	25,924
Total cost of lock	285,168

The foundation of concrete on piles and platform, being the cheaper of the two, will be the one that will be used in the estimates.

The costs of the navigable pass, the weirs, and the piers will also be different on gravel from what they were on rock.

The following are the estimates on this part of the work:

The coffer-dams are allowed to remain and become a part of the work, care being taken to cut them down to a foot or two below the level of the sills. The high weir has practically no coffer-dam, as what might be considered such is filled with concrete, and thus made the foundation for the wickets.

Navigable pass and low weir on gravel.

COFFER-DAM AND FOUNDATION.

Material.	Price.	Quantity.	Cost.
Coffer-dam:			
Piles, 18 feet long	$5.16 per pile, driven	$\frac{2}{5}$	$2 06
Sheet-piles	$6.65 per pile, driven	2	13 30
Stringers	$35 per 1,000 feet	980 feet	34 30
Small sheet-piles	$1.50 per pile, driven	2	3 00
Binders	$35 per 1,000 feet	7 feet	25
Bolts	3 cents per pound	200 pounds	6 00
Dredging	30 cents per yard	7 yards	2 10
Concrete	$5 per yard	5½ yards	27 50
Cut-stone	$15 per yard	$1\frac{13}{100}$ yard	16 95
Sills	$45 per 1,000 feet	34 feet	1 51
Labor			5 00
Total per running foot			111 97

High weir on gravel.

COFFER-DAM AND FOUNDATION.

Material.	Price.	Quantity.	Cost.
Piles, 13 feet long	$4.56 per pile, driven	¾	$3 36
Sheet-piles	$5.63 per pile, driven	2	11 26
Stringers	$35 per 1,000 feet	80 feet	2 80
Binders	$45 per 1,000 feet	208.8 feet	9 40
Sills	$45 per 1,000 feet	34 feet	1 51
Concrete	$5 per yard	3 yards	15 00
Gravel	50 cents per yard	2 yards	1 00
Riprap	$2 per yard	1 yard	2 00
Labor			5 00
Total per running foot			51 33

Pier on gravel.

The cost of foundation will be the same as that for the pass on gravel. The area of the pier will either be included in the coffer-dam for the pass or in that for the low weir, and therefore its cost can be obtained from the one given for these parts by omitting the cut-stone and sills and multiplying by 11.48.

We therefore have—

Foundation (111.97 − 18.46) × 11.48	$1,073 50
Masonry and capstan, as per previous estimate	3,385 44
Total	4,458 94

Abutment on gravel.

The estimate already made for the abutment supposes it to be founded on gravel, and therefore it need not be changed.

SUMMARY.

Bringing together the estimates just made, we find the following:

Navigable pass on gravel.

Coffer-dam and foundation, per running foot	$111 97
Pumping, per running foot	3 00
Appurtenances of the sole, per running foot	25 55
Wicket	48 57
Total	189 09

Low weir on gravel.

Coffer-dam and foundation, per running foot	$111 97
Pumping, per running foot	3 00
Appurtenances of the sole, per running foot	21 29
Wicket	40 47
Total, per running foot	176 73

High weir on gravel.

Coffer-dam and foundation, per running foot	51 33
Pumping, per running foot	3 00
Appurtenances of the sole, per running foot	17 03
Wicket	32 38
Total, per running foot	103 74
Pier	4,459 00
Abutment	8,646 00

TOTAL ESTIMATE FOR OHIO RIVER.

In making this estimate it is first necessary to have an approximate location for each lock and dam, and then to apply to the lengths thus determined the costs per running foot that are given above.

In the estimate based on rock-foundation the prices per running foot do not contain the 20 per cent. for contingencies which was subsequently added, nor is it contained in the estimates per running foot for gravel-foundations; adding this percentage to the calculated sums per running foot, we have the following general table of costs, from which we can obtain the approximate costs of all the parts of any dam, whatever may be its length. The abutment is supposed in all cases to rest on sand or gravel, as also the dams for closing island-chutes.

Table of costs of different parts.

	Rock foundation.	Gravel-foundation.
Lock	$179,610 00	$285,168 00
Navigable pass ......per foot	166 40	236 91
Low weir ......do	138 56	212 08
High weir ......do	130 27	112 49
Pier	5,049 00	5,351 00
Abutment	....	10,375 00
Dam behind island ......per foot	....	78 21

The following list gives the approximate locations for all the dams required on the Ohio in order to give 6 feet of water for navigation at all times. It is not supposed that these exact sites will be chosen, because no detailed examination with a view to choosing sites was made below Wheeling, nor would it have been judicious to have expended any money on a more extended examination in advance of the actual construction of at least one movable dam. The experience which will necessarily be acquired in such construction will probably lead to some modifications of the plans herewith presented, though I am firmly of the opinion that these modifications will be improvements in details and not changes in the general plan.

It should be added that the special survey made last summer between Pittsburgh and Wheeling demonstrated that there was an error of about 8 feet in the fall between these two cities as reported in the final report of Mr. Milnor Roberts. I believe that for this part of the river Mr. Roberts used the old surveys of 1838, and the inaccuracy was probably in them. This error shows that two more dams will be required on the Ohio than he supposed. According to our present information sixty-eight dams in all will be needed.

Approximate locations of proposed dams on Ohio River.

Number.	Miles from Pittsburgh.	Locality.	Length.	Lift of dam.
			Feet.	*Feet.*
1	4.7	Davis's Island	1,580+ 430	6.0
2	8.0	Duff's Bar	1,040+ 450	5.8
3	11.3	White's Bar below Hay's Run	1,350	6.4
4	13.8	Head of Deadman's Island	1,550	5.9
5	20.0	1,000 feet above Crow Island	1,160	6.0
6	26.5	Beaver Shoals	1,390	6.4
7	32.8	Foot of Montgomery's Island	1,425	6.8
8	37.8	Head of Georgetown Island	1,180	5.3
9	43.0	Foot of Babb's Island	1,500	6.0
10	54.5	Black's Island	1,000+ 600	6.0
11	62.0	Brown's Island	700+ 600	6.0
12	68.0	Head of Wells' Bar	1,350	6.0
13	77.5	Beech Bottom Bar	1,350	6.0
14	89.0	Head of Wheeling Island	1,000+ 700	7.0
15	94.0	Mouth of McMahon's Creek	1,100	7.0
16	102.0	2,000 feet below Big Grove Creek	1,200	6.0
17	112.5	1,400 feet above Fish Creek	750+ 750	6.0
18	119.3	2,600 feet below Opossum Creek	1,000	6.0

Approximate locations of proposed dams on Ohio River—Continued.

Number.	Miles from Pittsburgh.	Locality.	Length.	Lift of dam.
			Feet.	*Feet.*
19	127.3	500 feet below Fishing Creek	1,350	6.0
20	138.4	Middle of Wells' Island	1,000+ 800	6.0
21	146.7	Head of Petticoat Bar	1,380	6.0
22	158.8	1,400 feet below Middle Brother	1,600	6.0
23	170.0	2,400 feet below Duck Creek	600+ 950	6.0
24	180.4	Head bar of Cole's Island	2,300	6.0
25	188.4	Foot of Blennerhassett's Island	1,650	6.0
26	202.2	Head of Belleville Bar	1,100+ 750	6.0
27	212.3	1,600 feet above Swan Bar	1,600	6.0
28	223.0	Head Old Town Bar	1,400	6.0
29	233.0	600 feet below Upper Letart's Island	850+ 450	6.0
30	239.8	Lower end of Wolf's Bar	1,380	6.0
31	243.7	3,700 feet below Big Broad Run	1,050	6.0
32	256.0	Lower point of 8-Mile Island	1,300	6.0
33	267.0	Lower point of Gallipolis Island	1,600	6.0
34	285.3	460 feet above mouth of Pond Cut	1,400	6.0
35	289.1	Dogham Bar	1,450	6.0
36	308.3	Buffalo Creek Bar	1,350	6.0
37	315.8	Big Sandy Shoals	1,300	6.0
38	329.4	Ferguson's Bar	1,500	6.0
39	336.3	Jenalt's Shoals	1,500	6.0
40	351.3	Cub Creek Bar	1,150	6.0
41	364.5	Conoconneque Bar	1,750	6.0
42	382.0	Graham's Lower Station Bar	1,850	6.0
43	393.8	Upper end of Manchester	1,830	6.0
44	419.6	Lower end of Straight Creek Bar	1,800	6.0
45	444.5	Richmond Bar	1,850	6.0
46	458.0	Four-Mile Bar	1,700	6.0
47	485.6	Foot of Medoc Bar	1,670	6.0
48	501.3	Rising Sun Bar	1,950	6.0
49	509.5	Gunpowder Bar	2,000	6.0
50	530.8	Head Bar of Vevay Island	2,350	6.0
51	544.5	Locust Creek Bar	1,870	6.0
52	580.8	Grassy Flats	2,700	6.0
53	617.2	Christopher's Crossing	1,630	6.0
54	634.2	Moman's Bar	2,000	6.0
55	655.6	Foot of Upper Blue River Island	2,250	6.0
56	683.4	Lower Point of Flint Island	2,800	6.0
57	709.3	Head of Hog's Point Bar	2,100	6.0
58	731.2	Foot of Anderson's Bar	2,700	6.0
59	752.3	Little Hurricane Island	2,550	6.0
60	767.7	Scuffletown Bar	3,250	6.0
61	796.4	Henderson's Island	2,250+ 650	6.0
62	813.3	Head of Walnut Bend	3,550	6.0
63	838.2	580 feet above mouth of Wabash River	1,700+1,350	6.0
64	859.5	Battery Rock towhead	3,250	6.0
65	873.7	Head of Hurricane Island	2,300+1,370	6.0
66	907.5	Cumberland Island	2,800+1,000	6.0
67	942.5	Head of Grand chain	5,000	6.0
68	960.0	Just above mouth of Cache River	4,000	4.0

Sum of widths of main river	118,855
Sum of widths of island-chutes	10,840

I have had the above table prepared, not with the expectation that the sites selected will actually be chosen, but because such a table will undoubtedly give a sum of lengths of dam that cannot be greatly in error; and, therefore, it will represent the total length of dam required much better than can be obtained by multiplying the number of dams by any arbitrarily assumed averages, unless that average be determined from such a table.

It is impossible at present to tell how many of these locks and dams will rest on rock. I think, however, it will be safe for this general estimate to assume that twelve locks, eight navigable passes, six low weirs, and three high weirs will be on rock, and the remainder on gravel. Rock can be found on many shores for the establishment of the lock; and sometimes this rock can be found half way or more across the river. It

is very rare, however, to find it extending across the entire river without being so covered with gravel as to make it better not to carry the wiers down to it.

A width of 400 feet in the clear will be given to each navigable pass, and to each low weir. The width occupied by high weir will be estimated at the entire width of the river, diminished by the space occupied by the lock (assumed at 50 feet, on the supposition that part of the rock will be in the bank), by the width of the two weirs, and by the width of the two piers. The width of high weir will, therefore, be the width of the river, diminished by 878 feet. The sum of all the widths of river at the selected sites being 118,885 feet, the sum of the widths of high weir will be 118,883 — 872 × 68 = 59,521 feet; dividing this by 68, we find the average length of each high weir to be 875 feet. Bearing in mind that the high weirs on rock will only be found, if at all, in the upper part of the river, it will be safer to give these three high weirs an average width of 600 feet, thus making the average width of the 65 on gravel, 888 feet.

FINAL ESTIMATE.

12 locks on rock, at $179,610	$2,155,320
56 locks on gravel, at $285,168	15,969,408
8 navigable passes on rock, at $166.40 × 400	532,480
60 navigable passes on gravel, at $226.91 × 400	5,445,840
6 low weirs on rock, at $138.56 × 400	332,544
62 low weirs on gravel, at $212.08 × 400	5,259,584
3 high weirs on rock, at $130.27 × 600	234,486
65 high weirs on gravel, at $112.49 × 888	6,492,923
23 piers on rock, at $5.049	116,127
113 piers on gravel, at $5.351	604,663
68 abutments on gravel, at $10,375	705,500
10,840 linear feet of dam across island-chutes, at $78.21	847,796
Total cost of radical improvement of the Ohio	38,696,671

The above estimate has been made with a great deal of care, and is about the best that is possible under our present knowledge. It is a very difficult and uncertain task to make estimates for works of such magnitude in the absence of practical experience in construction of a single one, and I would not presume to undertake it at the present time, were it not for positive orders to do so. Considering the additional difficulties that will be encountered below the falls of the Ohio, on account of the short and uncertain season for work, and the enormous masses of sand that are transported by the current, which will undoubtedly cause delays and extra work, I think it would be safer to put the whole estimate at $40,000,000, which is at the rate of $41,365 per mile, the total length of the Ohio River being nine hundred and sixty-seven miles. Bearing in mind the enormous tonnage that would be borne on the river, if it were made navigable throughout the year, it does not seem unreasonable to request appropriations for its improvement at least equal to the sum that would be required to build a railroad of equal length.

Poor's Railroad Manual for 1873–'74 gives the following as the average cost per mile of the railroads in the United States, deduced from the sum of the stock and bonds of the companies owning them:

	Per mile.
New England States	$50,418
Middle States	79,427
Western States	50,550

These numbers include rolling-stock and expenses of all kinds.

In making appropriations for the radical improvement of the Ohio, it should be borne in mind that the radical improvement should commence at the upper end of the river, and that it would be unjust to the

commerce of the remainder of the river to entirely neglect it while work was progressing at the upper end. To remove obstructions, do necessary dredging, keep up the central office, and build the dikes required for the temporary improvement of the remainder of the river, would require about $200,000 per annum, gradually decreasing to $50,000 after the works were completed. The last sum, unless raised from tolls, would be perpetually required for the maintenance of the central office in charge of the works, the snag-boat for removing snags, and the two dredges, for which occupation would always be found in keeping the locks and passes clear of deposits and in improving the river for navigation when the dams were down.

To give some idea of how much money would be required to secure the radical improvement of the Ohio, and of the time necessary to construct the works, I have prepared the following table, based on the suppositions that the river below the dams will not be neglected, and that the tolls charged on the finished works will meet their own expenses for repairs and attendance. To construct one lock will probably require two seasons, and to construct one dam will require two seasons more. There is nothing, however, to prevent simultaneous work at all the sites selected; and, in fact, this would be the better method, in order to reduce to a minimum the disturbance to navigation.

I assume that whenever a part of the river is being prepared for locks and dams, that in this portion no part of the $150,000 allowed for gradually decreasing improvements by dikes, dredging, and other temporary works, will be required. In other words, if half the dams are under contract, there will only be required for miscellaneous expenditures, outside of the system of locks and dams, $\$50{,}000+\frac{\$150{,}000}{2}=\$125{,}000$.

The upper half of the river contains more dams than the lower half; but I have neglected this consideration, believing that it would be an unnecessary refinement.

Time for completion.	Annual appropriations.				Grand total.
	For locks and dams.	For snagging, dredging, &c.		Total in each year.	
Four years	$10, 000, 000	1st 4 years	$50, 000	$10, 050, 000	$40, 200, 000
Eight years	5, 000, 000	1st 4 years	125, 000	5, 125, 000	40, 700, 000
		2d 4 years	50, 000	5, 050, 000	
Sixteen years	2, 500, 000	1st 4 years	162, 500	2, 662, 500	41, 000, 000
		2d 4 years	125, 000	2, 625, 000	
		3d 4 years	87, 500	2, 587, 500	
		4th 4 years	50, 000	2, 550, 000	
Thirty-two years	1, 250, 000	1st 4 years	181, 250	1, 431, 250	43, 700, 000
		2d 4 years	162, 500	1, 412, 500	
		3d 4 years	143, 750	1, 393, 750	
		4th 4 years	125, 000	1, 375, 000	
		5th 4 years	106, 250	1, 356, 250	
		6th 4 years	87, 500	1, 337, 500	
		7th 4 years	68, 750	1, 318, 750	
		8th 4 years	50, 000	1, 300, 000	
Sixty-four years	625, 000	1st 4 years	190, 625	815, 625	47, 700, 000
		2d 4 years	181, 250	806, 250	
		3d 4 years	171, 875	796, 875	
		4th 4 years	162, 500	787, 500	
		5th 4 years	153, 125	778, 125	
		6th 4 years	143, 750	768, 750	
		7th 4 years	134, 375	759, 375	
		8th 4 years	125, 000	750, 000	
		9th 4 years	115, 625	740, 625	
		10th 4 years	160, 250	731, 250	
		11th 4 years	96, 875	721, 875	
		12th 4 years	87, 500	712, 500	
		13th 4 years	78, 125	703, 125	
		14th 4 years	68, 750	693, 750	
		15th 4 years	59, 375	684, 375	
		16th 4 years	50, 000	675, 000	

In conclusion I would add that I am not at all assured in my own mind that the system proposed will be found serviceable on the Ohio below the falls. But I do feel sure that it is a better system than that of permanent dams; and besides, it is the only other system that promises the depth required by the Senate Committee on Transportation. The system of dikes for controlling and guiding the current cannot be depended upon to give more than 4 feet at dead low water, and even this depth will require an immense development of these works.

However, if the system of movable dams is commenced at Pittsburgh, and gradually brought down the river, we will pass by degrees from hard bottom to soft sand, and while so doing we will acquire abundant experience as to the practicability of successfully encountering the shifting sands of the lower river.

It may be interesting in this connection to state that in France, between 1821 and 1853, the government spent 535,000,000 francs, equal to $107,000,000, in improving navigation, partly by canals and partly by rivers. During the same time private companies spent 100,000,000 francs, or $20,000,000, for the same purpose. I have no statistics on this subject since 1853, but the additional sum expended must be very large, as several canals have been built, and also all the larger movable dams in the Seine, Marne, and other rivers. These facts are well worth consideration, in view of the extraordinary resources recently displayed by France in bearing the burdens imposed by the disastrous war with Germany.

I inclose herewith a small drawing showing the proposed arrangement of lock and dam for the Ohio. I do not inclose drawings of the Chanoine wicket, as they accompanied my last annual report, although it is proper to add that I do not propose the use of the movable bridge shown in these drawings, but expect to work the wickets by a maneuvering boat.

I have been greatly indebted, in the labor of preparing this report, to the assistance of Lieut. F. A. Mahan, Engineers, who made the estimates on movable dams, and to Mr. W. Weston, assistant engineer, who made the estimates on the locks and on the dams for closing island-chutes.

Respectfully submitted.

WM. E. MERRELL,
Major of Engineers.

Brig. Gen. A. A. HUMPHREYS,
Chief of Engineers, U. S. A.

C C 10.

THIRD SUBDIVISION OF THE CENTRAL TRANSPORTATION-ROUTE.

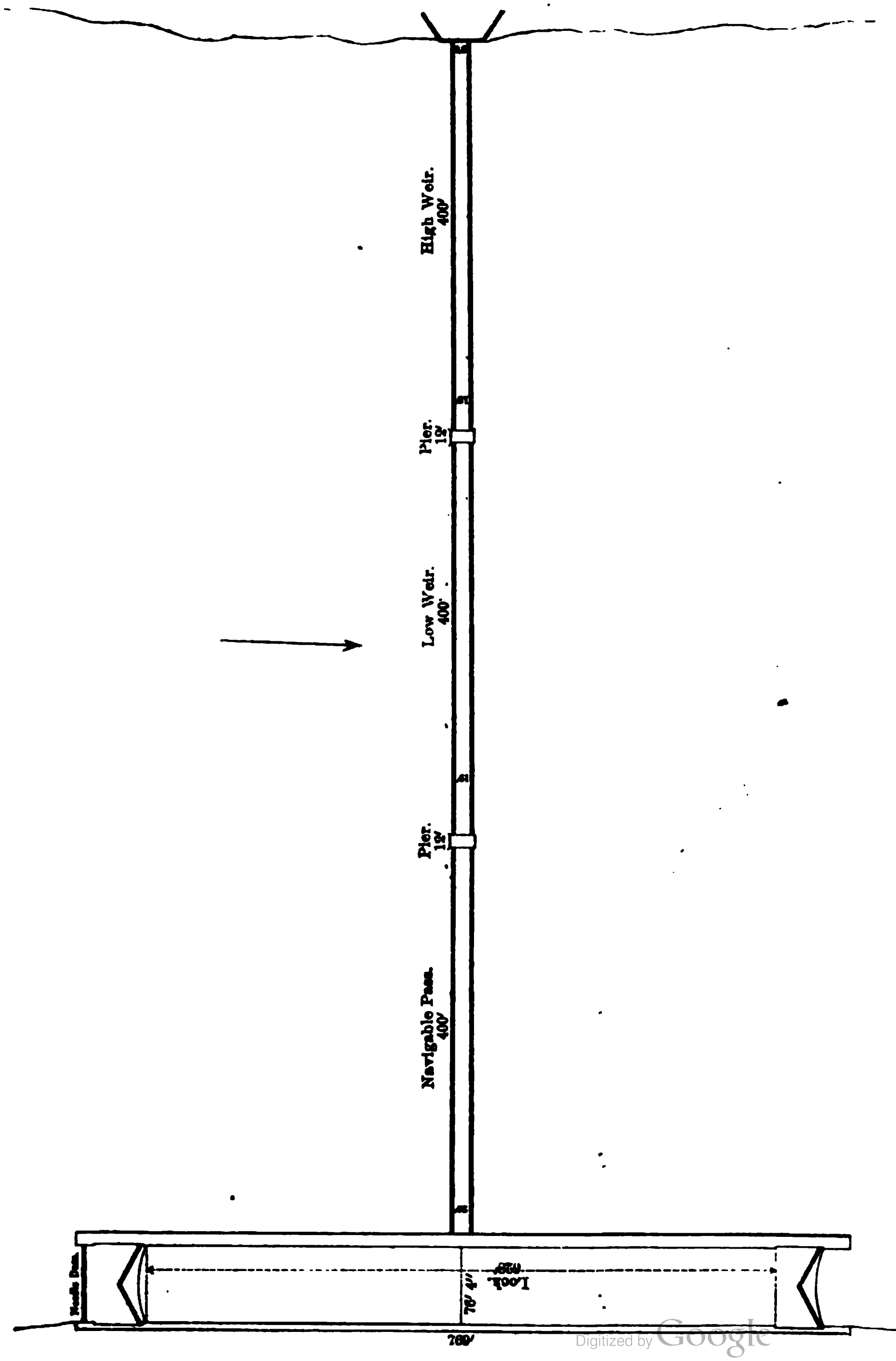
REPORT OF MAJOR WM. P. CRAIGHILL, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Baltimore, Md., January 13, 1875.

GENERAL: On the 2d of July, 1874, instructions were received from you of the following tenor:

* * * * * * *

The river and harbor act, approved June 23, 1874, contains an appropriation of surveys and estimates for the improvements recommended by the Senate Committee on Transportation-Routes to the Seaboard upon four routes indicated in the report of said committee, to be expended in such manner as will secure the greatest amount of exact information for each of said routes.


High Weir.
400'
Pier.
12'
Low Weir.
400'
Pier.
12'
Navigable Pass.
400'
Needle Dam.
Lock.
70' 4''
760'

The survey of that portion of the central route designated as "a connection by canal or a freight-railway, from the Ohio River, or Kanawha River, near Charleston, by the shortest and most practicable route through West Virginia to tide-water in Virginia," is assigned to you.

The nature and object of these surveys are fully set forth in the report of the committee, with its appendix and evidence, copies of which have been forwarded to you from this office for your information and guidance. You should, as far as practicable, carry out the views of the committee.

The sum of $48,000 will be allotted to you for this service from the above appropriation, and you will please enter upon this duty as early as practicable.

* * * * * * *

No delay was permitted in unnecessary preparations for the performance of the duty thus marked out, but some time was requisite for securing the services of persons competent to do thoroughly much and difficult work in the remainder of the season for such operations, which was then nearly or quite half past. It is proper here to explain that the responsibility resting upon me for the supervision of and disbursement of public funds for numerous works of river and harbor improvement in Maryland, Virginia, and North Carolina as far south as, and including, the Cape Fear River, made it impossible that I should take any part in the actual surveys, although frequent visits were made to those having them in charge, and a constant intercommunication was maintained by mail and telegraph.

The surveys were naturally divided into those relating to the water-line and those pertaining to the alternative freight-railway. The opinion has been more than once expressed that further surveys were necessary to procure more definite and detailed information concerning the water-line, and that a sum not less than $25,000 was required for that purpose. I had also, when called upon officially for an opinion, stated that $25,000 were also needed for surveys for the location of the alternative freight-railway, but in making that statement it was my understanding that the surveys for the freight-railway would be confined to a narrow tract quite near the water-line, for which it was to be the alternative. When, however, the field of investigation was extended by the Committee on Transportation to a search for a railway-line "from the Ohio River, or Kanawha River, near Charleston, by the shortest and most practicable route through West Virginia to tide-water in Virginia," it became obvious at once that more time and money would be necessary for proper surveys and estimates than had been expected. It was deemed fair to apply equal shares of the allotted $48,000 to the water-line and the railway surveys and estimates.

The report of the committee indicated (p. 182) the points to which special attention should be given in the water-line surveys. That report says:

* * * From the opinions expressed by the board of engineers it appears—

First. That the exact location of the tunnel is undetermined as yet. It is decided by the board that the size of the tunnel shall be changed to the dimensions above mentioned.

Second. That additional surveys are necessary in order to determine the question as to whether it is better to construct a canal from the summit to the Kanawha River, or to adopt the present plan of slack-water navigation, and that additional surveys are necessary for determining the principal points referred to in the report of the board.

* * * * * * *

The surveys relative to the summit-tunnel were committed, early in July, 1874, to the immediate charge of Lieut. Thomas Turtle, Corps of Engineers, United States Army, under instructions, from which the extract below is made:

* * * As soon as you can complete the necessary arrangements, you will proceed to the neighborhood of the Lorraine tunnel, on the Alleghany summit of the

central water-line, and there undertake such further investigations and surveys as may be required to furnish the information needed to enable a definite and final location to be made of that important feature of the line, and to put the work promptly under contract should Congress provide the means.

While locating the tunnel as a means of passing a great communication through the mountain, you will bear in mind also its office as the summit-level of a canal, and consider carefully the best means of connecting it with the canal or slack-water at either end, and of maintaining its supply of water by suitable feeding arrangements, assuming that supply to be sufficient.

Your service with the board of engineers last winter and spring, and your knowledge of the various points connected with this subject, discussed verbally and in written reports by them, make it unnecessary for me to give further than the general instructions above.

It is my expectation that, upon completing the field-duties thus indicated, you will supervise the preparation of illustrative drawings and maps, accompanied by a full report, in which, with other questions, I desire you to discuss the use of the tunnel by the application of horse-power or steam in the various modes which have been elsewhere tried and suggested, and all other matters pertaining to it.

It is important that a report, as complete as time and means will permit, shall be made to Congress at as early a day in the next session as possible; not later than January 1, 1875. * * * * * *

You will engage as many assistants, of different grades, as may be necessary, keeping down their compensation, and, indeed, all expenditures to the minimum limit compatible with fairness, and the accomplishment of much and reliable work in a comparatively short time. * * * * *

Free and full communication of your views at all times is invited. I shall watch your operations with very great interest, expecting most valuable and creditable results therefrom, to the attainment of which you shall have my constant and ready aid by every means whereby it can be properly rendered. * * *

The further surveys of the Greenbrier and New River were placed in the hands of Mr. N. H. Hutton, assistant engineer, under instructions, from which the following extracts are made, some of the other general paragraphs, not quoted, being identical in phraseology with those ahead given from the instructions of Lieutenant Turtle:

* * * * * * *

You will enter upon a resurvey of the Greenbrier River below Howard's Creek, and of New River below the Greenbrier, the objects being to fix the precise location of dams and other details of the slack-water navigation of these streams, with the collection of such additional information as will enable a detailed determination to be made of the location and cost of the canal, which by some engineers is considered a necessity for that part of the line, and by others a desirable though not a necessary alternative to the slack-water. You will keep in view also the possible advantages to be gained by resort to tunnels for avoiding difficult localities in the valley of New River specially, and thereby at the same time shortening the line, either of the slack-water or canal navigation. It is desired, if possible, that the information you gain will be such as to enable the work along that portion of the line to be put promptly under contract, should Congress provide the means.

Much valuable matter has been already accumulated concerning this part of the line through the labors of your able predecessors, which should be freely used.

* * * * * * *

Well organized and equipped parties of competent assistants were very speedily in the field and actively at work. Mr. Hutton commenced operations at the mouth of Howard's Creek on the Greenbrier River, but it soon became apparent that there was an unequal distribution of work between him and Lieutenant Turtle, and, in consequence, Mr. Hutton's parties were moved down to the mouth of the Greenbrier, and it was arranged that Lieutenant Turtle's parties should complete the Greenbrier field-work after finishing what was necessary for the summit division.

Still later in the season, and quite unexpectedly, I was directed to relieve Major Merrill, Corps of Engineers, of the charge of the improvement of the Great Kanawha River, and of its survey from the Great Falls to the Ohio River.

I was unable to meet Major Merrill until the middle of August, as he

was detained elsewhere by duties which he found himself unable to postpone. As soon thereafter as possible, about the 20th of August, 1874, the survey of the Great Kanawha was placed in the hands of Mr. A. M. Scott, the competent local assistant engineer, in charge of the improvement of the river. The instructions given him were the following:

* * * * * * *

Wishing to avail myself of your assistance and special local knowledge of the Great Kanawha River, having in view the necessity of further surveys to enable such a report to be made as seems to be required by the Senate Committee on Transportation, in order to the formation of a definite conclusion as to the proper method and the cost of permanently improving the river so as to give a *useful depth* of not less than 6 feet at all stages of water, which means actually a depth of not less than 7 feet, I have to request you to make such additional examinations from the falls to the mouth of the river as will give you the means for the following objects:

1st. A revision of Mr. Lorraine's estimate for sluice-navigation, with the help of a reservoir.

2d. A revision of Mr. Lorraine's estimate for a lock-and-dam navigation, with locks 240′ × 40′.

3d. An estimate of the cost of a lock-and-dam navigation, the lock to be about 250′ × 50′.

4th. An estimate of the cost of movable dams, with large locks.

The estimate should be in detail and be liberal. The accompanying report should treat the whole subject fully, and should be in my hands by December 15, 1874.

* * * * * * *

Under the phraseology of the Senate committee, designating the eastern termination of the freight-railway as "tide-water in Virginia," it became necessary to consider in that connection the whole line from Alexandria to Norfolk, and a communication by rail thence to the Ohio.

The language of the committee probably excluded from examination the claims to consideration of the route of the great and highly important and valuable artery of trade and travel known as the Baltimore and Ohio Railway, although (by its Parkersburg and Metropolitan branches, the former intersecting the Ohio in West Virginia, and the latter and its connections debouching on the Potomac River, the great tidal stream of Virginia, and by the main road and its branches passing through much of the territory of Virginia and West Virginia) the combination fills nearly the requirements of my instructions. The merits and advantages of that route are too well known by the whole country to require anything more in this report than a simple reference to them.

It became necessary, however, to look over the whole of Virginia south of the Baltimore and Ohio line, and to discover any other which was practicable through "West Virginia to tide-water in Virginia" in order to determine which was "the shortest and most practicable." Several railroads had been already constructed in whole or in part, and several others have been projected, and it was, therefore, desirable to utilize, as far as possible, the information already gained from previous surveys for those routes, and with that object to have the services of reliable civil engineers who had been engaged in responsible and important positions in connection with them.

About this time Mr. H. D. Whitcomb, the constructor of much of the Chesapeake and Ohio Railroad from Richmond to Huntington, resigned his position as its chief engineer. With your assent his services were at once secured, and, much to my gratification, he entered very promptly upon the work, under instructions, from which the following extracts are made:

* * * * * * *

The War Department has placed under my supervision, and expects a report upon, the survey of that portion of the "central line" of communication designated by the Senate Committee on Transportation as "a connecting-link by canal or a freight-railway, from the Ohio River, or Kanawha River, near Charleston, by the shortest and

most practicable route through West Virginia, and to tide-water in Virginia," the desire being to secure this season the greatest amount of exact information as to the object mentioned above, to be in readiness for consideration by Congress at its next session.

These instructions, while of a very general character, yet fix certain terminal limits and an intermediate belt of country over which our investigations are to extend, as far as the time and means at command will permit.

The western terminal point may be taken as the area of which Charleston is the center. The eastern is the tide-water in Virginia, which we may regard as practically extending from Alexandria to Norfolk.

Nature has herself well marked the proper central line of water-communication from the great valley of our great river, the Mississippi, to the Atlantic seaboard. She has stretched out the Ohio, and only that stream, far to the East. We naturally leave the Mississippi Valley by that line in looking for a connection with the Atlantic. The head-waters of the Ohio and its tributaries approach so nearly those of the James and Potomac, that attention is inevitably turned to those streams in considering a prolongation of the water-line to the Atlantic.

Our present instructions and other indications limit us to the James River route for the water-line. Much time and money have already been spent upon it, and two parties will again be engaged this season in further investigations which are deemed necessary, and are expected to settle all remaining doubts as to the cost and practicability of the line.

Your familiarity with the country traversed by the Chesapeake and Ohio Railroad, and as to improvements in location, &c., which might be made in it, induced me at once to desire your aid in considering the subject of the freight-railway, which has been recommended as an alternative to or connecting-link at the summit of the water-communication.

As you have agreed to undertake a portion of the necessary investigations, I will request you to direct your attention to the following points:

1st. To the conversion of the Chesapeake and Ohio line from the Ohio to Clifton Forge into a double-track freight-way, with due regard to its usefulness as a great through-route for passenger-travel.

2d. The construction of the continuation of such a railway from Clifton Forge eastward, terminating on the York or James River or Hampton Roads. This portion might possibly be by the present line of the Chesapeake and Ohio Railroad to Richmond, or via Lynchburg down the valley of the James, or otherwise to Richmond or City Point, or to Norfolk or City Point, via the South Side and Norfolk and Petersburg route.

Mr. C. P. Manning is considering the availability of the country between the Baltimore and Ohio line, and that of the Chesapeake and Ohio, for the proposed freight-railway. It might be deemed best to take the line of the Washington City, Virginia Midland and Great Southern Railway from Gordonsville to Alexandria, or from Gordonsville, via Fredericksburg, to tide-water near Quantico, or some other point on the Potomac near there. On this part of the investigation his examination and yours will cover some of the same ground. It would be well, therefore, that you and he should have a conference, so as to avoid double work, while availing ourselves of all reliable attainable information from every quarter, supplementing it, when necessary, by reconnaissances and surveys.

Our reports should be in Washington not later than January 1, 1875. I should wish them to be in my hands December 15, 1874, for combination and consideration, in order to the preparation of my own report to General Humphreys.

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Of course we must, in the performance of this duty, discard all preferences or prejudices toward any route or locality, but attempt to learn the real advantages and defects of all as to grade, length, terminal facilities, &c., considering only their availability in *whole*, in *part*, or in *combination*, to make a freight-railway worthy of the nation and useful to its people, while not interfering with passenger-travel. The question of maintenance and use, practically and suggestively, should be considered in your report, as well as those of construction, equipment, &c.

Our operations should be so conducted as to attract as little public attention as possible, and to avoid newspaper or individual controversy and criticism.

All this will follow our reports *ad nauseam* no doubt, and our only care should be to be prepared with facts and figures to sustain the opinions and results we may arrive at.

* * * * * * *

I esteemed myself very fortunate, also, in having the opportunity to engage, for the examination of the belt of country between the Baltimore and Ohio line and the Chesapeake and Ohio line, Mr. C. P. Manning, who had much personal familiarity with that region. He acted

under instructions similar in character and identical in language as far as possible with those given to Mr. Whitcomb.

Mr. Whitcomb having been appointed by the President of the United States a member of the last Board of Engineers, to whom was committed the subject of the consideration of the best method of permanently improving the navigation at the mouth of the Mississippi River, a duty which carried him to Europe, was unable to take a very large part of the field duties; but his chief assistants, Mr. R. H. Temple and Mr. C. R. Howard, were very competent, faithful, and zealous. The reports of Mr. Whitcomb and the subreports of those gentlemen are forwarded with this. The previous surveys of the Chesapeake and Ohio Railroad were freely used, and our thanks are due General Wickham on that account, and for many facilities afforded also in the surveys for the water-line.

My attention was called by influential and prominent persons specially to the line of the road formerly styled the Alexandria, Loudon and Hampshire, and the line of a road lately projected, and known as the Potomac and Ohio Road. The former has had a western extension projected, and is now called the Washington and Ohio Road.

The president of the Washington and Ohio Road, Mr. Lewis McKenzie, placed his maps, &c., at the disposal of Mr. Manning, and Mr. Bangs, president of the Potomac and Ohio line, gave all the information and assistance he could.

Mr. Manning had the aid of Mr. Addison Marbury, who joined much knowledge of the country traversed by him to a good experience as an engineer, and was specially recommended by those who seemed interested in the Washington and Ohio Road.

Mr. Manning's report is attached hereto. It will be found, like that of Mr. Whitcomb, exceedingly interesting and valuable. I feel much hesitation in differing from the conclusions formed by either of such able and experienced railroad-engineers, but it is my belief that the use of a railway, by opening it to competition by all, as is the case with a canal, would be found impracticable, as it would also be to transport 8,000,000 tons of freight per annum each way. It is also my conclusion that a double-track freight-railway from Charleston eastward to tide-water, answering the conditions which such a road should fulfill, and along the best route which could be adopted, would be between four hundred and four hundred and seventy-five miles in length. To take the road to the Ohio would require an extension of about fifty miles, and I should expect the cost of the United States freight-railway to come up to about $45,000,000, not including terminal facilities, rolling-stock, &c. These would cost about $25,000,000 more.

The freight-railway routes of which the tide-water termini are on the Upper Potomac have the advantage of a less length. Those terminating farther south have the advantages of much lower grades and a delivery of freight much nearer the ocean.

The date at which the money for the water-line surveys was provided by Congress was so late that it was necessary to keep the parties in the field up to the last day allowed by the cold weather. But little time was thus left for the preparation of detailed maps, without which a definite location of the parts of the line and complete estimates cannot be made. These maps and estimates are not yet ready, and cannot be for some time. I propose, however, to submit some general conclusions, which may, in my judgment, be safely drawn from them. The additional careful and extensive surveys of this season leave no reasonable room for doubt, it seems to me, of the practicability of taking through the 7-foot water-line, either by canal or slack-water, or a combination of

these methods, at a cost about as stated by the Barnard-Latrobe Board of Engineers in their report of March 18, 1874, in a resolution to the effect that the cost will not exceed $60,000,000, may reasonably be expected to be within $55,000,000, and may possibly not exceed $50,000,000.

No further surveys are necessary for locating the work in detail, and putting it out to contract, should funds be provided. The surveys for the water-line will also be very valuable in locating a railway, should it be decided to adopt that as the alternative, in whole or in part, for the water-line. Lieutenant Turtle has developed two other tunnel lines in the neighborhood of the White Sulphur Springs, either of which, as well as that located by Mr. W. R. Hutton in 1870, is available and practicable. It has been demonstrated that good sites can be had for all the dams on solid rock, and it is unnecessary to consider the case of founding on bowlders, as proposed by Mr. Lorraine, an idea to which the Board of Engineers with prudence and propriety demurred. His location has been improved upon in other important particulars. Here I will call attention to the peculiar exemption of this route from the influence of ice, as is proved by the facts stated in the report of Mr. Whitcomb, the results of reliable observations.

It would seem impossible that the future will not see the construction of this water-line, the location of which nature has pointed out in so plain and remarkable a manner, and for which she has afforded so many unusual advantages. If it should be desired to build a railway in advance of the water-line, it is my duty to say that its construction would very greatly impair the availability of the route for the location of an independent canal, and would interfere very seriously with a slack-water improvement.

In comparing the two methods of transporting freight, it is impossible to refrain from noting the greater capacity of the water-line over any double-track railway, the far less cost of maintenance and administration of the water-line, and the real difference of the first cost of the two is not so great as seems superficially apparent, for to the cost of any railway which the United States will be likely to build should properly be added the cost of its expensive equipment.

Special attention having been called to the Great Kanawha River, because, it is supposed, of its importance (apart from its being a link in the central water-line) as an available and the most economical means of transport of the immense mineral wealth on or near the banks of itself and its tributaries, a few words will be here added concerning that stream.

In his report to me, which is printed in the Annual Report of the Chief of Engineers for 1873, Mr. E. Lorraine presents two estimates—one of $2,000,000, for an open navigation through sluices in dams; another of a little less than $3,000,000, for a lock-and-dam navigation. The sluice navigation required the construction of the Meadow River reservoir, and is, necessarily, to some extent experimental. It was expected to be applied from Paint Creek down, as locks and dams are necessary from that point up to Kanawha Falls on account of the rapid fall. Both estimates of Mr. Lorraine contemplated providing for boats drawing 6 feet water, which is suitable for the river, whether viewed locally or in its connection with the central water-line. In the lock-and-dam system, estimated for by Mr. Lorraine, he considered locks twice as long and twice as wide (240′ x 40′) as those of the enlarged (proposed) James River Canal. His idea was, while making sufficient provision, as he thought, for the wants of the navigation independently of the through water-line, to arrange the dimensions of the locks so as to admit either

four of the canal-barges or three barges and a towing-tug. The aspects of the question have somewhat changed since Mr. Lorraine's report, although it was made in 1872.

In the first place, the Board of Engineers of 1874, in their report on the water-line, look to the advantages of larger locks on the canal, which would really necessitate larger rocks on a portion, at least, of the Kanawha, on the supposition even of the use of sluices below Paint Creek. The shippers of coal and salt, the great products of the country at present, say that the sluices would not accommodate their trade, and that locks 240′x 40′ are too small.

The operations carried on for years past by the Kanawha River Board, under authority of the State, with funds coming from tolls, have had for their object the creation or improvement of chutes at the falls or rapids between pools. The effect of this, while increasing the facility, or rather diminishing the difficulty, of passages between pools, has been to lower the pools themselves, and in some cases to develop shallows in them, hurtfully obstructing navigation. This process is evidently just the reverse of the lock-and-dam system. Persistence in the former will ultimately and certainly lead to the latter.

The sluice-and-dam method is intermediate between these extremes, but it is experimental, and is dependent for success upon a reservoir, besides being, as the users of the river claim, inadequate if successful.

If the system of movable dams with permanent locks could be made applicable to this river, it would seem to provide for all requirements and meet all reasonable objections.

I incline now to the opinion that the ordinary lock-and-dam system will finally be adopted for the whole length of the river, and with locks larger than those proposed by Mr. Lorraine, or the system of movable dams will be used.

Revised estimates have been made for the improvement, by locks and dams, of the Great Kanawha, locks to be 260 feet by 50, with the additional light thrown upon the subject derived from the recent surveys of Mr. Scott in 1874. It is gratifying to be able to state that the total does not differ materially from the estimates of Mr. Lorraine for a similar system, but with locks somewhat smaller, viz, $3,000,000.

It has not been practicable to prepare the estimates for the improvement by the use of movable dams, or the report to accompany the estimates.

It is expected that a report, with detailed estimates, will be made later for the whole water-line from the mouth of the Kanawha to Richmond.

Two maps are sent, to accompany report of Mr. Whitcomb, the first showing proposed route for a freight-railway between Lynchburg and Chesapeake Bay; and the second being a general map of first and second divisions of United States Government freight-railway survey down James River, giving location from Clifton Forge to a point twelve miles above Lynchburg.

To illustrate the report of Mr. Manning, there is sent a reduced copy of the nine-sheet map of Virginia, on which are located the several independent and combined routes to which he refers. To this sheet are attached profiles of the Washington and Ohio Railroad, and of the Potomac and Ohio Railroad.

Respectfully submitted.

WM. P. CRAIGHILL,
Major of Engineers.

Brig. Gen. A. A. HUMPHREYS,
Chief of Engineers U. S. A.

FREIGHT RAILWAY BETWEEN CHARLESTON, ON THE KANAWHA, AND DEEP WATER ON CHESAPEAKE BAY.

REPORT OF MR. H. D. WHITCOMB, ASSISTANT ENGINEER.

RICHMOND, VA., *December* 23, 1874.

COLONEL: In accordance with your instructions, the surveys necessary to ascertain the cost of a double-track freight-railway between Charleston, on the Kanawha, and certain points on the waters of Chesapeake Bay, where there is depth of water for the largest ships, have been made, and the following reports and estimates are submitted:

All of the lines contemplated had been previously surveyed, and in most cases built upon, except between Clifton Forge and Richmond, following the waters of James River; and the only surveys made under the appropriation have been between these points. Information as to other parts of the contemplated lines has been obtained from the officers of the Chesapeake and Ohio Railroad Company and from the published reports of other railroad companies in Virginia.

The surveys between Clifton Forge and Richmond were made by Messrs. C. R. Howard and R. H. Temple, to whom the credit of the work is due, and whose reports are submitted in lieu of a more detailed statement of my own.

The route of the proposed railway begins to the west, at Charleston, on the Kanawha River. It ascends eastwardly the valleys of the Kanawha and its tributaries, the New River, the Greenbrier River, and Howard's Creek, to the summit, or the crest, of the Alleghany Mountain, which is pierced at an elevation of less than 2,000 feet above tide. Thence it descends by the valleys of Dunlap's Creek and Jackson's River, tributaries to James River, and along the valley of James River, in general direction to the sea. The route is recommended with the confident expectation that in point of grades, cost, and other characteristics it has no rival.

The great obstacles to cheap transportation on a railway are adverse grades. If the amount of tonnage carried in each direction is the same, a level line is best, and if a large portion is carried in one direction, a descending grade in that direction is best. It is plain that a uniformly descending grade is not practicable between the waters of the Ohio and Atlantic ports, and we must select that route which approximates most closely to this to secure the most favorable results. In addition to this, the eastern terminus should be at a point where there is abundant depth of water, a free access to the sea for the heaviest ships, and where the climate secures a freedom from obstructions from ice.

The minor considerations which apply to other routes as well as to this, are that the road-bed and track should be as perfect as a due regard to economy can suggest; that every "grade crossing," whether of common roads or of railroads, should be avoided; that the bridges should be of indestructible materials and the rails of steel.

The trains should be run at a uniform speed and at such a rate as to develop the utmost economy. My impression is that this would be about eight miles an hour; and this is probably as much as the freight-trains carrying heavy tonnage now average over existing roads. By excluding all passenger or other fast trains, the trains on the proposed road could be run at uniform velocities, and, at the rate mentioned, with a very low liability to accident, and a maximum (or nearly so) of economy in fuel. On existing roads while the running time between terminal points may be sufficient for the requirements of the average speed mentioned, yet in consequence of freight-trains being forced to get out of the way of and to lie off for fast trains, they are frequently run at very high speeds—quite often of thirty miles an hour for limited distances. It is not safe to run cars at a high speed which are loaded for a low one, and consequently, on existing roads, either they are not loaded to their capacity or are run with a liability to accident. This is a very important element of expense.

If trains were run at a lower rate of speed the cars could be made lighter or else loaded more heavily, thus lessening the amount of dead-weight carried. At an average speed of eight miles an hour, with a maximum of twelve miles, cars could be loaded one-third more heavily than any prudent railroad official would be willing to risk as they are now run on roads doing a mixed business. On a double-track railway, with the trains run in this way, accidents would be rare, the trains would move with brief intervals between them and almost continuously, and an immense amount of tonnage could be transported. The intervals referred to need be only for such time as coaling the engines, the way-traffic, and the repairs of track would require, and it is not improbable that eight million tons of freight could be carried in each direction annually. If faster trains, either for passengers or express-freight, were required, a third or fourth track should be laid for their exclusive use.

In the following estimate, it will be observed that nothing is allowed for machinery and rolling-stock, or for buildings, except to a limited extent. On a railway where the

trains would move at a uniform and low velocity, if rigid inspection were used and suitable rules, with pecuniary penalties for violation, made and enforced, any persons or company could run their own machinery. In this way the railway would be open to competition just as canals now are, and the cost of transportation reduced to a minimum. The government would simply receive sufficient toll to maintain the railway and pay interest on its cost, and as a very large proportion of this road-management could better be done by contract, the number of men in the direct employment of the government would be quite limited.

From any point on the Great Kanawha, an important tributary of the Ohio, it is practicable, with a cost not exceeding that of existing railways between the Atlantic and the West, to construct a railway to tide-water on the waters of the Chesapeake Bay, *with grades against eastward-bound trains not exceeding* 20 *feet per mile*, and with grades in the opposite direction not exceeding 60 feet per mile. The amount of these maximum grades is very limited, and it is *practicable* to construct the railway from Charleston to tide-water with but one summit, which would be at the crest of the Alleghany Mountain and at an elevation of less than 2,000 feet above the level of the sea. I regret that limited time and appropriation did not permit a more thorough examination of this route, so that in point of distance and cost this *one summit-line* could be compared with the line as run.

Further surveys might show that it would be economy to reduce the 60-foot grade on the eastern slope of the Alleghany to 47 feet, and this can probably be done by increasing somewhat the tunneling now estimated for at the crest.

In making this statement, I wish to be understood as not stating possibilities merely, but that I would recommend these grades as most conducive to economic results, to any railway company expecting to transport from 5,000,000 to 10,000,000 tons of freight, annually, from the West to Atlantic ports over this route. The *possible* grades are lighter than those I have mentioned.

I take the liberty of suggesting to you, although beyond the limit assigned to me, that it is practicable to extend such a railway westwardly, with even lighter grades, to Cincinnati, and points farther west, as the valley of the Ohio forms a very direct continuation of this route from the sea.

From Charleston the railway would follow, or be parallel to, the line of the Chesapeake and Ohio Railroad to Clifton Forge on the waters of the James River. This road is constructed between these points with no grades facing westward over 21 feet per mile (except that for about 12 miles on the western slope of the Alleghany there are grades of 30 feet), and none in the opposite direction over 60 feet. There is one short grade facing westward slightly over 30 feet per mile on Jackson's River, but a very small sum would reduce it to the maximum stated. The grades ascending the Alleghany can be reduced to 20 feet per mile by taking the right bank of Howard's Creek for most of its course (the Chesapeake and Ohio Railroad occupying the left bank), and piercing the mountain with a tunnel 9,050 feet long in place of the present tunnel of 4,700 feet. This new tunnel would have two shafts of 160 and 190 feet depth respectively, dividing the tunnel into three nearly equal sections, and could be completed in less than three years. After passing the summit the grade would coincide generally with that of the Chesapeake and Ohio Railroad. The results of the surveys east of Clifton Forge are given in detail in the accompanying reports of Messrs. Howard and Temple, who had charge of the work.

The course of the James River is tortuous, and to save distance the line was run crossing several of its bends. To avoid the great bend of the river east of Lynchburg, a line was run as direct as practicable, conformable to the low grades, from Holcomb's Rock, nine and a half miles west of Lynchburg, passing southward of that city, to Concord Depot, on the Atlantic, Mississippi and Ohio Railroad, and thence to Richmond.

From Clifton Forge to Holcomb's Rock, the line, as run, is 61.83 miles in length and is shorter than a strictly river-line by one hundred and thirty-four miles. The maximum grade eastwardly is 20 feet and westwardly 47½ feet per mile. In this distance there will be no curve of less than 1,000 feet radius.

From Holcomb's Rock to Concord Station grades of 30 feet per mile are necessary, unless a considerable detour and expense are encountered. From Concord Station to Richmond the grades are more favorable.

If the grade of 20 feet per mile were adhered to, it would seem necessary for the line to follow the valley of the James with a considerable loss in distance. This route was not examined for want of time. The distance from Lynchburg to Richmond by canal is one hundred and forty-seven and a half miles; by line, as run, 117.7. It is probable that a railroad line down the valley of the river would be shorter than the canal, and although in the estimate of distance I have allowed a difference of but three miles, probably a greater saving could be made.

At Concord Station a connection is made with the Atlantic, Mississippi and Ohio Railroad, by which a line to Norfolk with favorable grades and curvature is secured. A connection with this line can also be made at Lynchburg, thereby saving the con-

struction of twelve miles of road, but an objection to a connection at this point is a grade of 47 feet per mile, going east, which occurs on a portion of the line between Lynchburg and Concord Station, where it leaves the valley of the former and ascends to the ridge or table-land south of the river. It is probably better, however, Norfolk being the objective point, to join this road at Lynchburg, and to use assisting power to overcome the grade referred to. From Concord Station to Petersburg the grades going east are under 20 feet per mile. Between Petersburg and Norfolk the grades in each direction are 39.6 feet per mile, but the line is almost absolutely straight, and, should it be thought necessary, an increase of the length of the road would probably develop grades as low as those existing elsewhere on this route.

A resurvey of the Atlantic, Mississippi and Ohio Railroad has recently been made, and the president of the company informs me that he will send such information relating to it as he may think useful. This information will be ready early in January.

The harbor of Norfolk is too well known to make any statement of its merits necessary in this report.

If Yorktown or Newport News is selected as the eastern terminus, the line would pass through or near the city of Richmond, either by the route surveyed by Mr. Temple or by the valley of the James from Lynchburg, and thence down the peninsula between the York and the James Rivers to deep water. The graduation of the line on the peninsula is light, and the grades would not exceed 20 feet per mile. At Yorktown or Newport News there is depth of water for the heaviest ships, and the approach from the sea is direct and easy.

If Alexandria or any other portion of the Potomac is selected as the terminus, I know of no route in connection with this under consideration where the grades can be reduced at practicable cost to less than 50 feet per mile. The shortest route by existing roads is by the Chesapeake and Ohio Railroad, from Clifton Forge to Gordonsville, and thence by the Virginia Midland (formerly Orange and Alexandria) Railroad to the Potomac. On this route there are several grades of 70 feet per mile, and going westward even this is sometimes exceeded.

The estimates submitted are for a double-track railway, independent of roads already built, although in many places it may be found economical to build parallel and in close proximity to them. The widths of cuttings are 30 feet at base in earth and 28 feet in rock, and the embankments are 26 feet wide on top. The prices assumed average more than those paid on the Chesapeake and Ohio Railroad for similar items, and in consideration of the facilities with which supplies can now be obtained, owing to the construction of that and other roads and of the James River and Kanawha Canal, they may be regarded as sufficient.

The track proposed for this road is a steel rail of 68 pounds per yard, supported by cross-ties 9 feet long and 7 by 8 inches, laid 2 feet between centers, in ballast 18 inches thick, and is estimated to cost, with the necessary sidings included, $33,500 per mile. The sidings on a railway of this character, where passing-places for fast trains will not be required, are estimated at about 6 per cent. of the total length of single track.

For seventy miles east of Charleston this route is through a coal-field, where fuel can be had at as low a cost and of as good quality as on any line in this country—an important item in the cost of transportation.

From the Alleghany, eastward, there are many deposits of iron-ore, which have been opened and worked, and have proved to be of good quality.

In other minerals and in products of the forest this route will compare favorably with others between the Atlantic and the West, and for agricultural products it has a fertile soil and a genial climate.

As evidence of the mildness of the winters along this route, I will state that since 1857, when an extraordinary snow-storm occurred in Virginia, I have never known the trains on the Chesapeake and Ohio Railroad sensibly detained from snow. I do not know of the existence of a snow-plow on any railroad in Virginia, and I know that there are none on the Chesapeake and Ohio Railroad, and that they have not been needed on it since 1857, a period of seventeen years.

The distances from Charleston to the several points suggested are as follows:

Charleston to Norfolk.

	Miles.	Total miles.
Charleston to Falls of Kanawha	35.86	
Falls of Kanawha to Clifton Forge	141.71	
Add possible increased distance over Chesapeake and Ohio Railroad	3.00	
		180.57
Clifton Forge to Lynchburg	71.23	251.80
Lynchburg to Norfolk (existing roads)	203.00	454.80

Charleston to Newport News as surveyed, maximum grade of 30 feet per mile.

	Miles.	Total miles.
Charleston to Lynchburg	251.80	
Lynchburg to Richmond	117.70	
		369.50
Richmond to Yorktown	60.00	429.50
Yorktown to Newport News	20.00	449.50

Charleston to Newport News, by James River Valley to Richmond, maximum grade, 20 feet per mile.

	Miles.	Total miles.
Charleston to Lynchburg	251.80	
Lynchburg to Richmond (estimated)	144.50	
		396.30
Richmond to Yorktown	60.00	456.30
Yorktown to Newport News	20.00	476.30

Charleston to Alexandria.

	Miles.	Total miles.
Charleston to Clifton Forge	180.57	
Clifton Forge to Gordonsville (existing roads)	115.69	
		296.26
Gordonsville to Alexandria (existing roads)	88.34	384.60

The cost of these several lines will be as follows. The cost of existing lines being ascertained from published reports, the cost of building and machinery being excluded:

Charleston to Norfolk, 454.8 miles.

		Totals.
Charleston to Falls of Kanawha	$1,000,000	
Falls of Kanawha to Clifton Forge	11,419,208	$12,419,208
Clifton Forge to Lynchburg	3,306,507	15,725,715
Lynchburg to Norfolk	5,402,621	
		21,128,336
454.8 miles track, at $33,500	15,235,800	36,364,136

Charleston to Newport News by line as run, 449.5 miles.

		Totals.
Charleston to Lynchburg (surveyed line)	$16,580,662	
Lynchburg to Richmond	3,588,407	$20,169,069
Richmond to Yorktown	699,960	20,869,029
Yorktown to Newport News	240,000	
		21,109,029
449.5 miles track, at $33,500	15,058,250	36,167,279

Charleston to Newport News, by James River Valley, 479.6 miles.

		Totals.
Charleston to Clifton Forge	$12,419,208	
Clifton Forge to Lynchburg (by river-route from five miles above Holcomb's Rock)	3,306,507	$15,725,715
Lynchburg to Richmond (assumed)	4,000,000	19,725,715
Richmond to Yorktown	699,960	20,425,675
Yorktown to Newport News	240,000	
		20,665,675
476.3 miles track, at $33,500	15,956,000	36,627,725

Charleston to Alexandria, 384.6 miles.

		Totals.
Charleston to Clifton Forge	$12,419,208	
Clifton Forge to Gordonsville	3,651,028	
Gordonsville to Alexandria	2,750,000	
		$18,820,236
384.6 miles track, at $33,500	12,884,100	31,704,336

To each of the above estimates of costs should be added the cost of such terminal facilities as would not be undertaken by private enterprise; also of such buildings as would be needed by officers and employés. It would be difficult to ascertain the amount needed without extended research, but the extra cost would probably be not less than $2,000,000.

I have had some difficulty in ascertaining the cost of existing roads from their published reports, but the above is believed to be a fair statement of probable cost.

It should be remembered that these estimates are for a double-track road throughout, with bridges of iron or masonry, laid with a heavy steel rail on a road-bed of ample width, and with heavy ballast.

The gauge, in order to accommodate the larger part of the rolling-stock on existing roads, should be 4 feet 8½ inches. If there is economy in using a narrower gauge, as many persons contend, that economy will apply to these lines as well as to any others.

I submit herewith the reports of Messrs. Howard and Temple, and maps and profiles of the lines surveyed.

Very respectfully, your obedient servant,

H. D. WHITCOMB.

Col. W. P. CRAIGHILL,
United States Engineers.

1.—FROM CLIFTON FORGE TO A POINT OPPOSITE HOLCOMB'S ROCK.

REPORT OF MR. C. R. HOWARD, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Richmond, Va., December 17, 1874.

DEAR SIR: In accordance with instructions conveyed in your letter of July 24, with transit, level, and cross-section parties complete, early in August I began a survey to "ascertain the cost of a railway from Clifton Forge to a point near Lynchburg."

The field-work of the survey terminated on October 16, since when the estimates of costs and the maps and profiles of the approximate railway location have been made.

The maximum grade adopted is 20 feet going east and 47½ feet going west, and the minimum radius of curvature (with the exception of one curve of 955 feet radius) is 1,000 feet.

On account of the present terminus of the James River and Kanawha Canal being at Pattonsburg, opposite Buchanan, that point is taken as the end of the first division.

ALIGNMENT, FIRST DIVISION, FROM CLIFTON FORGE TO PATTONSBURG.

The line, as approximately located, leaves the Chesapeake and Ohio Railroad at a point 450 feet west of the Clifton Forge Station, turning into the gorge at Clifton Forge, and following down the left bank of Jackson's River for one and one-half miles; thence bearing to the left, and crossing Cow Pasture River about 1,500 feet above its junction with Jackson's River, the junction forming the James River.

At Cow Pasture River cut-off No. 1 begins, crossing two ridges, and reaching James River at the mouth of Sinking Creek.

The distance by this cut-off is 7.45 miles; by the canal location, between same points 11.13 miles; and, with the same maximum grade, by the river line, 11.11 miles. From Sinking Creek the line runs nearly parallel to the river, and at the foot of the high ground, for 6.15 miles to Men's Branch, at which point cut-off No. 2 begins, the line crossing a ridge, and reaching James River near Saltpeter Cave. Between those points the distance by cut-off No. 2 is 1.9 miles, and by the river line, with same grade, 5.47 miles. From Saltpeter Cave the line follows the river cliffs for one mile, to the point at which cut-off No. 3 begins, thence crossing a ridge, and reaching the river at Pawpaw Run. Distance by cut-off No. 3, 0.96 mile; by river line, 3.59 miles.

From the lower end of cut-off No. 3 the line follows the river more or less closely to Pattonsburg, opposite Buchanan, the present terminus of the James River and Kanawha Canal. From Clifton Forge to Pattonsburg, the distance by the railroad line, with maximum grade of 20 feet per mile, and without crossing the river, is 28.37 miles; by the canal, with four crossings of the river, thirty-three miles; and by river line, without ascending grade or river-crossing, is thirty-eight.

ALIGNMENT, SECOND DIVISION, FROM PATTONSBURG TO A POINT OPPOSITE HOLCOMB'S ROCK.

At Pattonsburg, cut-off No. 4 begins, crossing a ridge, and reaching the river at a point 1.2 miles below, by railroad line, and 2.1 miles by canal or river line.

After reaching the river at lower end of cut-off No. 4, the line runs along a steep rock cliff, known as Wasp Rock, for 3,000 feet: thence making cut-off No. 5, to the crossing of James River. Distance by cut-off No. 5, one mile; by canal or river line, 2.6 miles.

From the river-crossing the line follows the right bank of the James River for 25½ miles to a point one-half mile below Reed Creek, and thence for a distance of five miles

of continuous 20-feet grade, it rises along the river cliffs, and crosses a low bridge, to a point opposite Holcomb's Rock, the terminal point of the survey under my charge.

The distance from Pattonsburg to the point opposite Holcomb's Rock is, by the railroad line, 33.46 miles; by canal, thirty-eight miles; and by river line, thirty-seven miles. From Clifton Forge to Holcomb's Rock, the total distance by railroad line—with 20 feet maximum grade going east, and one crossing of the river—is 61.83 miles, by canal, with five river crossings, seventy-one miles; and by river line, with one crossing, and without ascending grades going east, seventy-five miles.

GRADES.

On the first division the total rise of grades going east is 130.2 feet, and the corresponding fall 337.55 feet. The maximum grade of 20 feet per mile is used for 5.8 miles, and an average of 11 feet per mile for 1.3 miles, the remaining distance of 21.27 miles being on a level or descending grades.

On the second division, the total rise of grade going east is 131.83 feet, and the corresponding fall 269 feet. An average grade of 7 feet per mile is used for about 4.4 miles, and the maximum of 20 feet per mile held continuously for the last five miles, while for the remaining distance of 24.6 miles the grade is level or descending. From Clifton Forge to the end of the second division opposite Holcomb's Rock, the total rise and fall eastwardly are 262.03 and 606.55 respectively, and the lengths of maximum grades used are 20 feet per mile ascending for 10.8 miles, and 47½ feet descending for 5.18 miles.

CURVATURE.

On the first division the average curvature per mile is 76 degrees, and on the second division 95 degrees. The total curvature on both divisions from Clifton Forge to opposite Holcomb's Rock is 5,336 degrees, or 86¼ degrees per mile, the total length of curved lines being 34.77 miles, and of straight lines 27.06 miles.

TUNNELS, FIRST DIVISION.

Tunnel No. 1.—On cut-off No. 1, between Cow Pasture River and Lick Creek. Length 1,315 feet.

Tunnel No. 2.—On cut-off No. 2, between Men's Creek and Saltpeter Cave. Length, 1,900 feet.

Tunnel No. 3.—On cut-off No. 3, between Saltpeter Cave and Pawpaw Run. Length, 770 feet.

Tunnel No. 4.—Through projecting point of cliff about two and one-half miles above Jackson. Length, 165 feet.

TUNNELS, SECOND DIVISION.

Tunnel No. 5.—On cut-off No. 4, between Pattonsburg and Wasp Rock. Length, 200 feet.

Tunnel No. 6.—Through projecting point one mile above Balcony Falls. Length, 190 feet.

Tunnel No. 7.—Through crest of river-bluff two-thirds of a mile above Holcomb's Rock. Length, 600 feet.

The total tunnel length on the first division is 4,150 linear feet; on the second division 990 linear feet; or on both divisions one mile approximately.

All of the tunnel-material is limestone, except that of tunnel No. 7, which is a kind of granite.

The road-bed widths used in the estimate of quantities were, for earth-excavation, 30 feet; for rock-excavation, 28 feet; and for embankment, 26 feet; and the corresponding side-slopes were mostly ⅓ to 1, 1 to 1, and ½ to 1. In many of the excavations, however, where the material would plainly be in great part rock, side slopes of ¼ to 1 were used, and in corresponding embankment, 1½ to 1. In large through cuts and tunnel-approaches, a certain depth of earth overlying rock was assumed, and the sectional area taken accordingly. The classification of excavation, when ¼ to 1 slopes were used, was, in all cases, two-thirds rock. The tunnels were estimated as 28 feet wide, and 21 feet in length, or 18.75 cubic yards of excavations per linear foot.

Masonry was estimated as 26 feet in width for undergrade, and 34 feet for overgrade bridges.

At several points below Pattonsburgh, where the line runs along cliffs close to the canal, retaining-walls are needed, and are included in the estimate.

At Lick Creek, section 4, where the embankment is over 60 feet in height, a comparison of cost of earth-work and iron trestling was made, with a result so much in favor of the former that borrowed material has been estimated for in all cases of excess of embankment on both divisions.

Two exhibit-sheets accompany this report, one for each division, containing quantities, prices, and amounts for graduation, masonry, and bridging on each section; also a profile of each division, and a topographical map on a scale of two and one-half miles to the inch, showing the corresponding alignment. The field-maps, on a scale of 100 feet to the inch, showing in detail the topography and the railroad location on which the following estimate is based, will be forwarded with the remainder of the field-notes and estimate details.

Exhibit of work to be done upon the first division of the United

Locality.	GRADUATION.										
	Earth.		Loose or soft rock.		Solid rock.		Other items.		Tunnel-excavation.		Total graduation to be done.
	Cubic yards.	Price.	Cubic yards.	Price.	Cubic yards.	Price.	Cubic yards.	Price.	Cubic yards.	Price.	
Section 1	1,649	$0 30	1,648	$0 50	47,258	$1 00	....	......	....	......	$48,577
2	1,395	30	1,394	50	34,017	1 00	23,691	$0 40	....	......	44,609
3	6,720	30	6,720	50	10,815	1 00	169,664	40	....	......	84,057
4	14,175	30	14,174	50	39,996	1 00	158,376	40	24,656	$4 00	213,310
5	16,111	30	16,112	50	26,896	1 00	96,951	40	....	......	78,565
6	16,689	30	16,690	50	17,094	1 00	1,809	40	....	......	31,170
7	27,463	30	27,463	50	20,950	1 00	....	40	....	......	42,920
8	6,669	30	6,669	50	26,678	1 00	....	40	....	......	32,014
9	3,114	30	3,113	50	12,462	1 00	14,154	40	....	......	20,614
10	3,011	30	3,011	50	12,044	1 00	41,229	40	....	......	30,945
11	5,699	30	5,699	50	22,794	1 00	....	40	....	......	27,353
12	3,301	30	3,300	50	13,206	1 00	....	40	....	......	15,846
13	1,470	30	1,470	50	5,880	1 00	35,331	40	....	......	21,188
14	2,532	30	2,531	50	10,128	1 00	8,057	40	....	......	15,377
15	1,950	30	1,951	50	7,804	1 00	15,070	40	....	......	15,392
16	5,746	30	5,745	50	8,754	1 00	21,979	40	....	......	22,143
17	10,698	30	10,699	50	12,105	1 00	11,209	40	....	......	32,146
18	17,861	30	17,860	50	35,829	1 00	....	40	35,625	4 00	192,617
19	2,133	30	2,132	50	27,479	1 00	79,553	40	....	......	61,007
20	7,917	30	7,916	50	38,648	1 00	....	40	14,438	4 00	102,733
21	7,309	30	7,309	50	4,980	1 00	4,423	40	....	......	12,597
22	5,561	30	5,560	50	79,423	1 00	....	40	3,094	4 00	96,947
23	6,381	30	6,382	50	24,048	1 00	13,404	40	....	......	34,915
24	7,596	30	7,596	50	35,098	1 00	....	40	....	......	41,175
25	576	30	576	50	....	1 00	18,751	40	....	......	7,961
26	6,517	30	6,517	50	....	1 00	....	40	....	......	5,213
27	6,944	30	6,945	50	....	1 00	....	40	....	......	5,556
28	15,248	30	15,248	50	....	1 00	15,023	40	....	......	18,207
	212,435	......	212,432	......	581,386	......	728,674	......	77,813	......	1,354,054

***States Government Freight Railroad, State of Virginia,* 1874.**

MASONRY.															TOTAL AMOUNT OF SECTION.	
Abutments.		Piers.		Arch.		Second-class masonry.		Coping.		Square drains.		Cost of foundation and other contingencies on masonry.	Total masonry to be done.		Truss-bridging to be done.	To be done.
Cubic yards first-class masonry.	Price.	Cubic yards.	Price.	Cubic yards.	Price.	Cubic yards.	Price.	Cubic yards.	Price.	Cubic yards.	Price.					
774	$10 00							22	$16 00	141	$4 00	$800	$9,456		$12,600	$70,633
						31	$7 00	4	16 00	417	4 00		1,949			46,558
1,463	10 00	1,532	$12 00					60	16 00	270	4 00	1,500	36,554		37,800	158,411
				193	$16 00	829	7 00	5	16 00				8,971			222,281
										302	4 00		1,208			79,773
				35	16 00	173	7 00	3	16 00				1,819			32,989
										158	4 00		632			43,552
										538	4 00		2,152			34,166
										558	4 00		1,832			22,446
383	10 00							6	16 00	111	4 00	300	4,670		4,400	40,015
519	10 00							6				400	5,686		4,400	37,439
										170	4 00		680			16,526
						50	7 00	20	16 00	110	4 00		1,110			22,298
						439	7 00			54	4 00		216			15,593
										84	4 00		336			15,728
				85	16 00			8	16 00	231	4 00		5,485			27,628
				141	16 00	684	7 00	8	16 00	142	4 00		7,740			39,886
										150	4 00		600			193,217
				273	16 00	1,227	7 00	18	16 00	118	4 00		13,717			74,724
				59	16 00	257	7 00	3	16 00	43	4 00		2,963			105,696
				66	16 00	332	7 00	6	16 00	131	4 00		4,000			16,597
										136	4 00		544			96,791
				98	16 00	497	7 00	7	16 00				5,159			39,674
				31	16 00	159	7 00	4	16 00	43	4 00		1,845			43,020
				34	16 00	136	7 00	3	16 00				1,544			9,505
				23	16 00	105	7 00	3	16 00	78	4 00		1,463			6,676
																5,556
										256	4 00		1,024			19,231
3,139		1,532		1,038		4,919		186		4,141		3,000	123,355		59,200	1,536,609

Exhibit of work to be done upon the second division of the United

Locality.	GRADUATION.											MASONRY.	
	Earth.		Loose or soft rock.		Solid rock.		Other items.		Tunnel-excavation.		Total graduation to be done.	Abutments.	
	Cubic yards.	Price.	Cubic yards.	Price.	Cubic yards.	Price.	Cubic yards.	Price.	Cubic yards.	Price.		Cubic yds. 1st-class bridge-masonry.	Price.
Section 29	9, 554	$0 30	9, 554	$0 50	27, 773	$1	3, 488	$0 40	......	....	$36, 811	2, 774	$10
30	......	......	......	......	89, 223	1	......	......	......	....	89, 223	......	....
31	15, 239	30	15, 239	50	60, 958	1	......	......	3, 750	$4	88, 149	......	....
32	12, 395	30	12, 395	50	49, 580	1	73, 524	40	......	....	88, 906	2, 484	10
33	3, 440	30	3, 440	50	6, 901	1	1, 306	40	......	....	10, 175	......	....
34	2, 784	30	2, 784	50	......	....	8, 943	40	......	....	5, 804	......	....
35	6, 566	30	6, 565	50	......	....	......	......	......	....	5, 253	......	....
36	7, 318	30	7, 317	50	29, 271	1	......	......	......	....	35, 125	......	....
37	11, 354	30	11, 353	50	45, 415	1	......	......	......	....	54, 497	......	....
38	5, 778	30	5, 778	50	3, 361	1	......	......	......	....	7, 983	......	....
39	6, 249	30	6, 250	50	......	....	409	40	......	....	5, 164	......	....
40	9, 329	30	9, 329	50	6, 561	1	......	......	......	....	14, 025	......	....
41	6, 956	30	6, 955	50	8, 804	1	10, 674	40	......	....	18, 632	......	....
42	8, 218	30	8, 219	50	732	1	......	......	......	....	7, 306	......	....
43	5, 817	30	5, 816	50	10, 979	1	28, 501	40	......	....	27, 032	1, 102	10
44	10, 335	30	10, 335	50	1, 698	1	......	......	......	....	9, 966	......	....
45	7, 403	30	7, 403	50	11, 675	1	......	......	3, 563	4	31, 850	......	....
46	4, 810	30	4, 811	50	32, 647	1	......	......	......	....	36, 496	......	....
47	......	......	......	......	51, 283	1	......	......	......	....	51, 283	......	....
48	3, 872	30	3, 873	50	22, 358	1	......	......	......	....	25, 456	......	....
49	8, 000	30	8, 000	50	31, 561	1	......	......	......	....	37, 961	......	....
50	4, 028	30	4, 028	50	24, 489	1	764	40	......	....	28, 017	......	....
51	3, 417	30	3, 418	50	34, 619	1	......	......	......	....	37, 353	......	....
52	8, 438	30	8, 437	50	33, 749	1	......	......	......	....	40, 498	......	....
53	8, 506	30	8, 506	50	34, 024	1	......	......	......	....	40, 829	......	....
54	5, 931	30	5, 931	50	23, 725	1	......	......	......	....	28, 469	......	....
55	7, 588	30	7, 587	50	30, 349	1	......	......	......	....	36, 419	......	....
56	9, 547	30	9, 547	50	38, 188	1	......	......	......	....	45, 826	......	....
57	2, 512	30	2, 511	50	10, 043	1	......	......	......	....	12, 053	......	....
58	4, 734	30	4, 733	50	18, 934	1	......	......	......	....	22, 721	......	....
59	977	30	976	50	80, 302	1	......	......	......	....	81, 063	......	....
60	4, 807	30	1, 806	50	19, 224	1	139, 728	40	......	....	78, 960	......	....
61	8, 693	30	8, 692	50	34, 771	1	131, 755	40	......	....	94, 427	......	....
62	15, 092	30	15, 092	50	60, 647	1	......	......	11, 250	4	117, 721	......	....
	229, 687	......	229, 680	......	933, 844	....	399, 092	......	18, 563	....	1, 351, 479	6, 360	....

States Government Freight Railroad, State of Virginia, 1874.

Masonry. Piers: Cubic yards.	Piers: Price.	Arch: Cubic yards.	Arch: Price.	Bridge-masonry: Cubic yards 2d-class.	Bridge-masonry: Price.	Coping: Cubic yards.	Coping: Price.	Square drains: Cubic yards.	Square drains: Price.	Vertical wall: Cubic yards.	Vertical wall: Price.	Cost of foundation and other contingencies on masonry.	Total masonry to be done.	Total amount of section. Truss-bridging to be done.	Total amount of section. To be done.
						39	$16	88	$4			$1,200	$29,916	$4,400	$71,127
								412	4	3,693	$3		12,727		101,950
		60	$16	254	$7	7	16	80	4				3,170		91,319
2,190	$12					50	16					3,000	54,920	72,800	216,626
															10,175
		20	16	100	7	4	16						1,084		6,898
															5,253
								113	4				452		35,575
								111	4				444		54,941
				59	7	4	16						477		8,460
								61	4				244		5,408
								154	4				616		14,641
		28	16	222	7	5	16	41	4				2,246		20,884
				34	7	4	16						302		7,608
						22	16					1,000	12,372	4,400	43,804
		24	16	106	7	3	16	93	4				1,546		11,512
								54	4				216		32,066
								91	4				364		36,860
				89	7	4	16						687		51,970
				10	7	4	16						134		25,590
															37,961
		26	16	208	7	8	16	87	4				2,318		30,365
										661	3		1,983		39,336
		51	16	390	7	13	16	107	4	4,391	3		17,355		57,853
				51	7	4	16	62	4	2,614	3		8,511		49,340
		76	16	445	7	7	16	188	4				5,195		33,664
								265	4				1,060		37,479
								175	4				700		46,526
		72	16	456	7	12	16	62	4				4,784		16,837
		66	16	391	7	10	16	237	4				4,901		27,622
		69	16	297	7	3	16	228	4	2,588	3		11,907		92,990
		98	16	301	7	3	16	741	4				6,687		85,647
		199	16	596	7	6	16			2,543	3		15,081		109,508
		83	16	295	7	3	16	462	4				5,289		123,010
2,190		872		4,304		215		3,912		16,490		5,200	207,718	81,600	1,640,797

APPROXIMATE ESTIMATE OF COST OF CONSTRUCTION FIRST DIVISION, FROM CLIFTON FORGE TO PATTONSBURG.

Graduation, masonry, and bridging of 28.37 miles, at $54,163.17 per mile..	$1,536,609
Track, 28.37 miles, at $33,500 per mile	950,395
Land-damages and damages to buildings, 28.37 miles, at $400 per mile....	11,348
Engineering, 28.37 miles, at $1,000 per mile	28,370
Total, 28.37 miles, at $89,063.17 per mile	2,526,722

APPROXIMATE ESTIMATE OF COST OF CONSTRUCTION SECOND DIVISION, FROM PATTONSBURG TO A POINT OPPOSITE HOLCOMB'S ROCK.

Graduation, masonry, and bridging of 33.46 miles, at $49,037.56 per mile ..	$1,640,797
Track, 33.46 miles, at $33,500 per mile	1,112,910
Land-damages and damages to buildings, 33.46 miles, at $500 per mile....	16,730
Engineering, 33.46 miles, at $1,000 per mile	33,460
Total, 33.46 miles, at $83,798.48	2,803,897

APPROXIMATE ESTIMATE OF COST.

Recapitulation.

First division, 28.37 miles, at $89,063.17 per mile	$2,526,722
Second division, 33.46 miles, at $83,798.48 per mile	2,803,897
Total cost of construction, 61.83 miles, at $86,214.12 per mile.......	5,330,619

The location and grades in which the above estimate is made may be adjusted so as to lessen somewhat the quantities of earth-work and masonry obtained; but, as at the more difficult points the location adopted is the result of several trial-lines, probably it cannot be greatly bettered, as to cost, by any change in the alignment; neither would the adoption of a 30-foot instead of a 20-foot maximum grade, going east, be of any very considerable advantage in lessening the aggregate cost, as it would only affect materially that of three or four sections.

As now estimated, the line crosses the Valley Railroad at grade, but it can be changed to a crossing above grade without sensibly affecting the estimate given.

There is one curve of 955 feet radius, beginning a few hundred feet below the crossing of James River, but a more elaborate examination of the ground in that vicinity might secure a better alignment at no greater cost.

Very respectfully, your obedient servant,

CONWAY R. HOWARD.

H. D. WHITCOMB, Esq., *Civil Engineer.*

2.—FROM HOLCOMB'S ROCK TO RICHMOND.

REPORT OF MR. R. H. TEMPLE, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Richmond, Va., December 15, 1875.

SIR: Having been charged by you with the duty of making a survey and estimate of cost of a double-track railway from Holcomb's Rock to Richmond, the following report is respectfully submitted:

Field-work was commenced on the 1st of August and completed on the 15th of November, 1874, during which time one hundred and eighty miles of line were surveyed.

The distance from Holcomb's Rock to Richmond, by the line as located, is one hundred and thirty-two and a half miles; passing through the counties of Bedford, Campbell, Appomattox, Buckingham, Cumberland, Powhatan, Chesterfield, Goochland, and Henrico.

The route selected may be described as follows: Commencing at a point on the south bank of James River, near Holcomb's Rock, the line at once leaves the river, and, passing eastwardly through a gap in Fleming's Mountain, gains the elevated and broken plateau which lies between the foot-hills of the mountain and the river.

Following the plateau, it crosses Judith's Creek and the Blackwater, passes through the suburbs of Lynchburg farthest from the river, and, striking directly across the

drainage of Fishing, Opossum, and Beaver Creeks, reaches Concord, situated upon the ridge which divides the waters of the James and Staunton Rivers.

From Concord the line runs parallel with, and 100 feet distant at right angles from, the Atlantic, Mississippi and Ohio Railroad, to a point three miles west of Appomattox Court-House, where it crosses said railroad and follows the dividing-ridge between the waters of the James and Appomattox Rivers, passing three miles north of Appomattox Court-House.

Holding this ridge, it runs south of Willis Mountain and Buckingham Court-House, and near the county-seats of Cumberland and Powhatan, to the head of Manakin Creek, two miles west of Tomahawk Station, on the Richmond and Danville Railroad; thence down Manakin Creek to its confluence with James River, which it crosses at this point thirteen miles above Richmond by canal; thence up Tuckahoe Creek, passing north of Richmond, and crossing the Richmond, Fredericksburg and Potomac Railway, three miles north of the city; thence descending the valleys of Bacon Quarter Branch and Shockoe Creek to Broad-street depot of the Chesapeake and Ohio Railway.

The Atlantic, Mississippi and Ohio is crossed twice; the Washington City, Virginia Midland and Great Southern is crossed once, with overgrade crossings, while it is proposed to pass under the Richmond, Fredericksburg and Potomac Road.

No grade is used exceeding 30 feet per mile going east or west, except for a distance of three miles descending eastward into Richmond, where 45 feet per mile was found necessary.

The minimum radius used is 1,000 feet, and this in one or two cases only, it being rarely necessary to use a radius of less than 1,910 feet.

The material from Holcomb's Rock to Concord consists chiefly of mica-schist, easily worked, but will not stand in excavation at a slope of less than one-half to one. Granite of superior quality for masonry can be had on this part of the line.

From Concord to Richmond the excavation will be mostly in earth, and, the line being located for the greater part of the distance upon the ridge, very little masonry is required except at the crossing of James River, where good granite may also be had, with water-transportation to the bridge-site.

Tables of curvature and grades, also distances between prominent points upon survey, as well as distances between same points by existing routes, are given.

Your attention is called to the fact that five miles in distance is gained over the line, as surveyed, by keeping the south side of James River to Richmond.

The following estimates do not include cost of fencing, wharves, depot and office building, engine-houses, machine-shops and machinery, rolling-stock, or the salaries of any other than engineer-officers during the period of construction, which is assumed at twenty months. The cost of equipment, including items enumerated, I estimate at $25,000 per mile.

A profile and general map (scale 2¼ miles to the inch) of line from Holcomb's Rock to Richmond accompanies this report. Thirty miles of the section-maps (scale 400 feet to one inch) are completed.

Having in my possession data upon which to base an accurate estimate of cost of double-track railway from Richmond to Yorktown and Newport News, it is also submitted.

R. H. TEMPLE.

H. D. WHITCOMB, Esq.,
Civil Engineer.

ESTIMATED COST OF THIRD DIVISION, FROM HOLCOMB'S ROCK TO CONCORD.

Graduation, masonry, and bridging, 23.07 miles, at $95,340 per mile....	$2,199,493 80
Land-damages, 23.07 miles, at $500 per mile..........................	11,535 00
Track, 23.07 miles, at $33,500 per mile..............................	772,845 00
Engineering, 23.07 miles, at $1,000 per mile.........................	23,070 00
Total cost of third division....................................	3,006,943 80
Average cost per mile..	130,340 00

ESTIMATED COST OF FOURTH DIVISION, FROM CONCORD TO A POINT THREE MILES EAST OF CUMBERLAND COURT-HOUSE.

Graduation, masonry, and bridging, 54.49 miles, at $18,000 per mile........	$980,820
Land-damages, 54.49 miles, at $500 per mile............................	26,245
Track, 54.49 miles, at $33,500 per mile................................	1,825,415
Engineering, 54.49 miles, at $1,000 per mile...........................	54,490
Total cost of fourth division......................................	2,887,970
Average cost per mile..	53,000

ESTIMATED COST OF FIFTH DIVISION, FROM A POINT THREE MILES EAST OF CUMBERLAND COURT-HOUSE TO RICHMOND.

Graduation, masonry, and bridging, 53.9 miles, at $19,800 per mile	$1,067,220
Land-damages, 53.9 miles, at $500 per mile	26,950
Track, 53.9 miles, at $33,500 per mile	1,805,650
Engineering, 53.9 miles, at $1,000 per mile	53,900
Total cost of fifth division	2,953,720
Average cost per mile	54,800

SUMMARY OF COST OF DOUBLE-TRACK RAILWAY FROM HOLCOMB'S ROCK TO RICHMOND.

Third division, 23.07 miles	$3,006,943
Fourth division, 54.49 miles	2,887,970
Fifth division, 53.90 miles	2,953,720
Total cost	8,848,633
Average cost per mile	67,310

ALIGNMENT.

Holcomb's Rock to Richmond.

Division.	Length in miles.	Total curvature.	Curvature per mile.	No. of circles turned.
		° ′	° ′	
No. 3	23.07	1,991 28	86 19.4	5.53
No. 4	54.49	2,910 29	53 24.6	8.09
No. 5	53.90	2,688 03	49 52.2	7.47
Total	*131.46	7,590 10	57 44.6	21.09

* This is the distance from Holcomb's Rock to a point on the Chesapeake and Ohio Railroad one mile west of Broad-street depot.

SUMMARY OF GRADES.

Going eastward.

Ascending.		Descending.		Level.
Rate per mile, in feet and decimals.	Length of plane, in feet.	Rate per mile, in feet and decimals.	Length of plane, in feet.	Length of plane, in feet.
30.096	113,712	44.880	15,100	99,777
26.400	11,900	36.960	7,400	....
23.760	4,400	30.096	199,040	....
22.176	6,030	27.456	10,700	....
21.120	5,850	26.400	5,400	....
19.536	7,300	21.120	7,000	....
15.840	16,700	19.536	10,571	....
12.672	5,000	17.424	3,000	....
11.616	9,300	13.200	26,200	....
8.448	7,800	11.088	7,000	....
7.920	4,300	10.560	6,000	....
7.392	10,000	9.504	4,570	....
6.336	31,600	8.448	7,000	....
2.640	24,000	6.336	7,000	....
....	....	3.168	8,500	....
....	....	1.584	12,000	....
Totals	257,842	....	336,481	99,777
Total feet	....	....	....	694,100
Total miles	....	....	....	131.46

	Miles.
Distance from Holcomb's Rock to Lynchbur	9.5
Distance from Lynchburg to Concord	13.2
Distance from Concord to Richmond, by route surveyed	109.4
Distance from Lynchburg to Richmond, by route surveyed	123.0

	Miles.
Distance from Lynchburg to Richmond, keeping on south side of James River and following location of Danville Railroad from Tomahawk Station to Richmond	117.7
Distance from Richmond to Lynchburg by Atlantic, Mississippi and Ohio Railroad and Richmond and Danville Railroad	124.0
Distance from Richmond to Lynchburg by canal	147.5

ESTIMATED COST OF DOUBLE-TRACK RAILROAD FROM JAMES RIVER STATION, CHESAPEAKE AND OHIO RAILROAD, TO YORKTOWN, VA.

Graduation, masonry, bridging, land-damages, engineering expenses, and all other work necessary to prepare road-bed for track, 58.33 miles, $12,000 per mile	$699,960
Track, 58.33 miles, at $33,500 per mile	1,954,055
Total cost	2,654,015
Average cost per mile	45,500

ESTIMATED COST OF DOUBLE-TRACK RAILROAD FROM YORKTOWN TO NEWPORT NEWS

Graduation, masonry, bridging, land-damages, engineering expenses, and all other work necessary to prepare road-bed for track, 20 miles, at $12,000 per mile	$240,000
Track, 20 miles, at $33,500 per mile	670,000
Total cost	910,000
Average cost per mile	45,500
Total cost from James River Station, Chesapeake and Ohio Railroad, to Newport News	3,564,015

SUMMARY OF COST OF DOUBLE-TRACK RAILWAY FROM HOLCOMB'S ROCK TO NEWPORT NEWS.

From Holcomb's Rock to Richmond	$8,848,633
From Broad street depot to James River station	1,000,000
From James River station (railroad) to Yorktown	2,654,015
From Yorktown to Newport News	910,000
Total cost from Holcomb's Rock to Newport News	13,412,648
Average per mile (213 miles)	62,970

FREIGHT-RAILWAY FROM NAVIGABLE WATER OF OHIO AND KANAWHA RIVERS THROUGH VIRGINIA AND WEST VIRGINIA, TO THE TIDE-WATER OF THE POTOMAC RIVER.

REPORT OF MR. CHARLES P. MANNING, ASSISTANT ENGINEER.

BALTIMORE, *December* 31, 1874.

SIR: In obedience to the instructions of your letter of July 18, of the current year, I at once proceeded to an investigation of the question regarding the availability of the belt of country lying between the Baltimore and Ohio and Chesapeake and Ohio Railroads for the construction of an intermediate "freight-railway" from the navigable waters of the Ohio and Kanawha Rivers through the territories of West and Old Virginia to the tide-water of the Potomac River; and now have the honor to present the following condensed report of the results of this investigation.

Your letter informed me of the fact that the field of investigation was large and the limit of both time and pecuniary means for accomplishing all the objects in view comparatively small; consequently my field-operations have been restricted to a simple personal reconnaissance of the district of country mentioned with the aid of two professional assistants and the use of the aneroid barometer.

Your instructions called for special examination of the projected railways of the Washington and Ohio and Potomac and Ohio Railroad Companies; therefore, my first step was directed to the procurement of all information in relation to the subject of inquiry that was in possession of, and would be given to me by, the officers of these companies.

My applications to the presidents of these corporations, Messrs. McKenzie and Bangs, met with prompt and kindly attention, and I at once ascertained that the estimates of cost, and all other reported matter in relation to the extension of the Washington and Ohio Railroad, were based upon actual surveys, while those of the projection and construction of the Potomac and Ohio Railroad were mainly founded upon a general,

and not special professional, knowledge of the natural features of the country to be dealt with.

Such being the result of my primary examinations, I concluded to avail myself of the recorded facts of the surveys of the Washington and Ohio Railroad Company and expend my limited pecuniary means upon a thorough reconnaissance of the route indicated for the Potomac and Ohio Railroad.

This reconnaissance was made during the months of August and September last, and proved so satisfactory that I confidently offer the accompanying approximate estimates of the length and cost of constructing the Potomac and Ohio Railroad, in comparison with those of the Washington and Ohio Railroad, which have been obtained from more exact and reliable information.

Referring to the report of the Potomac and Ohio Railroad Company, addressed to the United States Senate committee, dated the 28th of January, 1874, it will be seen that the chosen point for a passage of the Blue Ridge Mountains was at Swift Run Gap, on the line separating the counties of Greene and Rockingham.

At the request, however, of their president, Mr. Bangs, my reconnaissance was made by way of Thornton Gap, in that range of mountains.

Commencing upon the Potomac River near the mouth of Quantico Creek, at a point recently known as Potomac, in Prince William County, the reconnoitered line passes through the southern part of that county and through portions of Stafford, Fauquier, Culpeper, and Rappahannock Counties, to the summit of the Blue Ridge; thence into the valley of the Shenandoah River, through the counties of Page, Rockingham, and Augusta, to the base of Shenandoah Mountain, the front ridge of the great Alleghany range.

Ascending the valley of North River to the summit of Shenandoah Mountain, the line passes through the southern part of Pendleton, and thence through the middle of Highland and Pocahontas Counties to the headwaters of the Gauley and Elk Rivers, upon the western slope of the Greenbrier or Cheat Mountain—better known in this locality as Elk Mountain—whence it descends the valley of Elk River, through the counties of Webster and Braxton, to the border of Clay County, near the confluence of Birch and Elk Rivers.

From the last-named point the direct line to the Ohio River leaves the valley of Elk River and crosses the dividing-ridge to the headwaters of the Little Kanawha River, and, following the valley of the latter, falls into the surveyed line of the Washington and Ohio Railroad at the mouth of Tripolet's Run, in Calhoun County, whence the two roads have a common route through the counties of Roane, Wirt, Jackson, and Mason to Point Pleasant, on the Ohio River.

From this direct line I have projected branches to intersect the Chesapeake and Ohio Railroad at both Gauley Bridge and Charleston, with the view to a connection with the navigation of the Ohio River at Huntington by way of the last-named road.

Also, in order to cover the probable field of inquiry, I have projected a cross-line or branch from Buckhannon, on the Washington and Ohio Railroad, to the valley of Elk River, where the branch to Charleston diverges from the main line of the Potomac and Ohio Railroad near the confluence of the Elk and Birch Rivers, thus forming a continuous line from Alexandria to Charleston by way of the Washington and Ohio Railroad.

No doubt a practicable line might be traced for the Potomac and Ohio Railroad from the confluence of Elk and Birch to the Ohio River more nearly approaching the direct course indicated in the report of Mr. Bangs; but it is very doubtful if the saving in measured distance by this route would compensate for the certain increase in cost of construction and probable increase of roadway and working expenses due to the character of such a line.

From the confluence of Elk and Birch eastward, up the valley of the former, to the summit of Elk Mountain, I have assumed for the Potomac and Ohio Railroad ten miles less of distance to traverse than has been heretofore reported by competent engineers to be their computation from the results of personal reconnaissance and local information.

From the summit of Elk Mountain to the Potomac River nothing has been added to the known traveled distances from point to point of the reconnoitered route, except where a gain of distance is absolutely requisite to a development of the line laterally upon the slopes of the mountain-ranges, in order to keep within the limits of practicable construction without exceeding those prescribed for grades and curves.

In regard to my assumptions of lengths for the branches from the Potomac and Ohio Railroad to Gauley Bridge and Charleston, respectively, and from the Washington and Ohio Railroad to Charleston, each line has the benefit of the lowest reasonable estimate of increase upon its known air-line length; which estimate in neither case exceeds 33 per cent. of the latter.

Having been for some years past personally acquainted with the general physical features of the belt of country under discussion, and especially familiar with those of the region traversed by the Washington and Ohio Railroad from Alexandria to the valley of the South Branch River, I have not deemed it necessary to examine and crit-

cise in detail the land surveyed for the extension of that road to the Ohio River; but accepting as facts the data obtained from the surveys, have confined my criticisms to a revision of the estimates of cost obtained therefrom, and upon the results of this review have framed new estimates.

In disposing of the question of general availability for the construction of a great freight-railway between the Ohio and Potomac Rivers, I answer—

First. That the belt of country referred to is certainly available by both routes here pointed out.

Secondly. That through the great Alleghany Mountains there is no available route intermediate to these two.

Thirdly. That, of the two designated routes, the one chosen for the Washington and Ohio Railroad is preferable in almost every particular of comparison. And, finally, that so far as the natural resources of the country bear upon the question of its availability for general railway purposes, the greater portion of this entire belt abounds in the very best of building-materials, fuel, and minerals of almost every kind.

So much has been already published regarding the peculiar features, productions, and resources of Virginia and West Virginia, with which you are especially familiar, that I refrain from encumbering this report with any unnecessary matter of detail.

My estimates of cost contemplate the making of a road-bed 28 feet wide at subgrade in the open cuts and 26 feet in the tunnels and upon embankments, with two main tracks, and additional side-tracks to the extent of one-fifth of the whole length of the road.

All the tracks to be made of steel rails weighing 70 pounds per yard, and the best of other necessary materials, well laid in full ballast.

All the bridges to be built of either stone or iron, and all the tunnels lined with either stone or brick.

The surveys for the extension of the Washington and Ohio Railroad having been guided, in a great measure, by the system of grades originally adopted for its construction to the coal-fields of Hampshire County only, it was necessary for me, in availing myself of the results of these surveys, to apply the same system of grades to the reconnoitered line of the Potomac and Ohio Railroad, in order that the comparison of length and cost by each of the two routes might be made upon a common basis.

The system referred to is simply the constant application of the maximum grades of 52.8 feet per mile ascending eastward and 79.2 feet per mile ascending westward, wherever their use will tend toward the reduction of either the length or cost of road, or both together. And I think its application in the cases before us is as fair a test of the general availability of the country for the construction of either of the two roads as it is a test of their comparative merits.

In adopting this system for the present occasion I do not assume that the limits of 52.8 feet and 79.2 feet per mile are necessary to a proper development of this intermediate railway scheme, but am of the opinion that they very rarely approach the true medium of gradients for the character of country to be dealt with and traffic to be accommodated.

In further explanation of the subjoined estimates, it is proper for me to remark that they are based upon an assumed traffic of not less than three millions to four millions of tons annually; that is to say, two millions of tons eastward and one million of tons westward of through freight, together with possibly one million of tons, or the equivalent thereof, of mixed local business distributed along the road between its terminal extremities.

To maintain the road-bed and tracks in perpetuity under such a traffic, I estimate that the annual cost would not be less than $5,000 per mile of double-track road and sidings for the first two or three years of its use, and, with the best management, fully $3,000 per mile thereafter.

To equip the road with depots, machine-shops, rolling-stock, &c., necessary to accommodate the assumed amount of traffic, I estimate that no less a sum of money should be provided than $17,000,000, since the rolling-stock alone would probably cost fully $15,000,000.

Referring you to the published report of the Potomac and Ohio Railroad Company, I would call attention to its erroneous assumption regarding the extreme elevations to be overcome, and the percentage of increase in length of constructed road over the air-line distance between terminal extremities, in comparison with the results of my reconnaissance.

And I may properly ask attention, also, to its assumption that a railway of the character and extent of the one proposed can be economically worked under a system of tolls similar to that of canal improvements.

My own opinion regarding the latter question is adverse to this assumption, and decidedly in favor of a consolidated system of toll and transportation as the only practicable as well as economical method of operation.

For convenient reference, I have condensed the details of my estimates of length, cost, &c., of these two projected railways in tabular form, together with estimates of the probable length and cost of projected branches, as follows:

POTOMAC AND OHIO RAILROAD.

Estimates of the length and cost of construction.

Section.	Distances.		Graduation, masonry, and small bridges.	Tunnels.		Large bridges.		Main and side tracks.	Total cost.	Average cost per mile.	Aggregate cost.
	Local.	Total.	Cost.	Length.	Cost.	Length.	Cost.	Cost.			
Commencing at Quantico—	*Miles.*	*Miles.*		*Feet.*		*Feet.*					
To eastern foot of Blue Ridge	56	56	$1, 008, 000	....	....	850	$150, 000	$1, 840, 000	$2, 998, 000	$53, 500	$2, 998, 000
To western foot of Blue Ridge	38	94	1, 460, 000	10, 000	$1, 500, 000	150	30, 000	1, 254, 000	4, 244, 000	111, 900	7, 242, 000
To North River Gap	42	136	756, 000	....	....	600	120, 000	1, 386, 000	2, 262, 000	53, 800	9, 504, 000
To Greenbrier River	101	237	4, 236, 000	10, 000	1, 500, 000	150	30, 000	3, 333, 000	9, 099, 000	90, 100	18, 603, 000
To confluence of Elk River and Birch Run	70	307	3, 612, 000	15, 000	2, 250, 000	850	150, 000	2, 310, 000	8, 322, 000	118, 900	26, 925, 000
To Mount Pleasant	85	392	1, 412, 000	11, 000	1, 650, 000	700	120, 000	2, 805, 000	5, 987, 000	70, 400	32, 912, 000
Total	392	392	12, 484, 000	46, 000	6, 900, 000	3, 390	600, 000	12, 928, 000	32, 912, 000	84, 000	32, 912, 000

WASHINGTON AND OHIO RAILROAD.

Estimates of length and cost of construction.

Section.	Distances.		Graduation, masonry, and small bridges.	Tunnels.		Large bridges.		Main and side tracks.	Total cost.	Average cost per mile.	Aggregate cost.
	Local.	Total.	Cost.	Length.	Cost.	Length.	Cost.	Cost.			
Commencing at Alexandria—	*Miles.*	*Miles.*		*Feet.*		*Feet.*					
To east foot of Blue Ridge	53	53	$1, 060, 000	....	....	750	$150, 000	$1, 749, 000	$2, 959, 000	$56, 000	$2, 959, 000
To Shenandoah River, west foot Blue Ridge	11	64	516, 000	4, 600	$690, 000	....	....	363, 000	1, 569, 000	142, 600	4, 528, 000
To eastern foot South Branch Mountain	48	112	966, 000	....	....	750	150, 000	1, 584, 000	2, 700, 000	56, 250	7, 228, 000
To Buchanan	126	238	5, 459, 000	24, 000	3, 600, 000	2, 400	480, 000	4, 158, 000	13, 697, 000	108, 700	20, 925, 000
To Point Pleasant	122	360	1, 950, 000	11, 900	1, 785, 000	1, 800	360, 000	4, 026, 000	8, 121, 000	66, 500	29, 046, 000
Total	360	360	9, 951, 000	40, 500	6, 075, 000	5, 700	1, 140, 000	11, 880, 000	29, 046, 000	80, 700	29, 046, 000

A table of distances between certain localities upon the Ohio and Great Kanawha Rivers, and other localities upon the Potomac River, by air-lines, and projected and existing railway-lines through West and Old Virginia.

	Between Huntington and Alexandria.	Between Huntington and Quantico.	Between Huntington and Mathias Point.	Between Charleston and Alexandria.	Between Charleston and Quantico.	Between Charleston and Mathias Point.	Between Point Pleasant and Alexandria.	Between Point Pleasant and Quantico.
	Miles.	*Miles.*	*Miles.*	*Miles.*	*Miles.*	*Miles.*	*Miles.*	*Miles.*
Air-line	290	276	292	247	233	249	275	261
Railway	412	414	416	360	362	364	360	392
Differences	122	138	124	113	129	115	85	131
Increase	42-100	50-100	43-100	46-100	55-100	46-100	31-100	50-100
Projected railway	52	324	27	52	324	27	....	392
Surveyed railway	258	....	....	258	....	....	310	....
Partly-constructed railway	....	....	45	....	....	45	....	....
Existing railway	102	90	344	50	38	292	50	....
Summary	412	414	416	360	362	364	360	392

NOTE.—By Chesapeake and Ohio and Orange and Alexandria Railroads, 381 miles, or 54-100 increase upon air-line between Charleston and Alexandria.

Grades.

Washington and Ohio Railroad—ascending grades.			Potomac and Ohio Railroad—ascending grades.		
Westward.	Miles.	Rise in feet.	Westward.	Miles.	Rise in feet.
From Alexandria to Point Pleasant	144.5	7,400	From Quantico to Point Pleasant	181	7,800

Washington and Ohio Railroad—ascending grades.			Potomac and Ohio Railroad—ascending grades.		
Eastward.	Miles.	Rise in feet.	Eastward.	Miles.	Rise in feet.
From Point Pleasant to Alexandria	182	6,900	From Point Pleasant to Quantico	187.5	7,300

NOTE.—If the total ascents of each of these two lines of road were accumulated in two inclined planes representing the extreme limits of grade assumed, viz. 52.8 feet per mile ascending eastward and 79.2 feet per mile ascending westward, to a common average apex of 7,000 feet for one and 7,500 for the other, the combined planes would consume in one case 222 miles, and in the other 237 miles, or fully six-tenths of the entire length of each road.

To the foregoing tabular statements I have to add the following estimates of the probable cost of the projected branches of the Potomac and Ohio Railroad:

From Greenbrier River to Gauley Bridge	$8,700,000 00
From confluence of Elk River and Birch River to Charleston, of the Washington and Ohio Railroad	3,640,000 00
From Buckhannon to Charleston	7,280,000 00

To further condense all these statements of length and cost, they may be briefly summed up as follows:

From Point Pleasant, on the Ohio River—

To Quantico via Potomac and Ohio Railroad, 392 miles	$32,912,000 00
To Alexandria via Washington and Ohio Railroad, 360 miles	29,046,000 00
Difference, 32 miles	3,866,000 00

From Charleston, on the Kanawha River—	
To Quantico via Potomac and Ohio Railroad, 377 miles	$30,775,000 00
To Alexandria via Washington and Ohio Railroad, 360 miles	28,205,000 00
Difference, 17 miles	2,570,000 00
From Gauley Bridge, on Kanawha River—	
To Quantico via Potomac and Ohio Railroad, 324 miles	$27,303,000 00

In conclusion, I have only to remark that in studying this question I have been alone guided by professional views; also that I am indebted to the reports of Mr. Blythe, chief engineer of the Washington and Ohio Railroad, and Mr. Campbell, chief engineer of the Charleston and State Line Railroad, for much valuable information, and to the personal services of Mr. Addison Marbury, civil engineer (who, as principal assistant of Mr. Blythe, made the surveys for the extension of the Washington and Ohio Railroad to the Ohio River, in 1870) for still more important assistance in everything pertaining to the subject of investigation.

With great respect, I am, sir, your obedient servant,

CHAS. P. MANNING,
Civil Engineer.

Col. WM. P. CRAIGHILL,
Engineer Corps, United States Army.

CC II.

SOUTHERN ROUTE—FROM THE MISSISSIPPI RIVER TO THE ATLANTIC OCEAN BY WAY OF THE TENNESSEE RIVER.

REPORT OF MAJOR WALTER M'FARLAND, CORPS OF ENGINEERS.

By act of Congress approved June 23, 1874, $200,000 were appropriated for the purpose of making the surveys recommended by the Senate Select Committee on Transportation-Routes to the Seaboard during the session then closing.

The survey of that particular route designated in the report of the committee as the southern route was assigned to me, and by letters from the Office of the Chief of Engineers, dated June 29, 1874, and July 15, 1874, I was informed that $46,000 of the appropriation would be set aside for the survey of this route.

The Senate select committee, in their discussion of the southern route, had suggested two things, viz:

First. The improvement of the Tennessee River from its mouth to Knoxville, so as to give 3 feet of navigation at lowest stage of water.

Second. A communication by canal or freight-railway, from some convenient point on the Tennessee River, in Alabama or Tennessee, by the shortest and most practicable route to the Atlantic Ocean.

To gain the information needed for carrying out the suggestions of the committee, it became necessary to undertake the following surveys, viz:

1st. Of the Tennessee River from Knoxville to Paducah. This would include the Tennessee division, which had never been surveyed, of the proposed southern line of water communication between the Mississippi River and the Atlantic Ocean. (See Report of the Chief of Engineers for 1872, page 509.)

2d. Of the Coosa River, from Rome, Ga., to Gadsden, Ala., and of the Ocmulgee and Altamaha Rivers, from Macon, Ga., to Darien, Ga., designated respectively as the Coosa and Altamaha divisions of the proposed line of water-communication between the Mississippi River and the Atlantic Ocean by way of the Tennessee River, neither of which had ever been surveyed. These, as well as the survey of the Tennessee

division mentioned in the preceding paragraph, were required, in order to complete the survey of this proposed water-line.

3. Of a railroad-route from the Tennessee River to the Atlantic Ocean. The only conditions which the recommendation of the committee placed upon this survey were, 1st, that the route should start "from some convenienu point on the Tennessee River in Alabama or Tennessee"; and, 2d, "that it should proceed, by the shortest and most practicable route, to the Atlantic Ocean."

As the report of the committee showed that it desired to compare the relative costs of a rail and of a water route from the Tennessee River to the Atlantic Ocean, it was deemed advisable to take the initial point of the canal-survey of 1872 as the initial point of the proposed railway-survey. This initial point was Guntersville, Ala., the most southerly point reached by the Tennessee River in its passage from the Alleghanies to the Mississippi, and the point at which a great through line of transportation from Saint Louis to the South Atlantic coast of the United States would naturally leave the Tennessee River, both in order to save distance and to avoid the obstructions found in the passage of the river through the mountains. From this point the line was to be run by the shortest and most practicable route to the sea-coast, at or near Savannah or Brunswick, Ga., the terminus to be fixed by the course which, under the given conditions, the nature of the country might compel the line to follow.

Subsequently it was decided to survey a second route, beginning on the Tennessee River at the mouth of the Hiawassee, thence up the valley of that river and across the Blue Ridge, connecting at Anderson, S. C., and Athens, Ga., with the railways already built from these points, to the Atlantic coast.

Four parties were thus formed:

1. For the survey of the Tennessee River.
2. For the survey of the Coosa, Ocmulgee, and Altamaha Rivers.
3. For the survey of the railway-route from Guntersville to the coast.
4. For the survey of the railway-route up the Hiawassee Valley.

The first, third, and fourth parties took the field in September, 1874, the second in October, 1874.

The field-work of the first party was going on at the close of the fiscal year ending June 30, 1875.

That of the second was completed in February, 1875, and the reports were in by April.

That of the third and fourth parties was not completed until the month of June, 1875, and their reports are not yet in.

The results were as follows:

1.—SURVEY OF THE TENNESSEE RIVER FROM KNOXVILLE TO PADUCAH, TO GIVE THREE FEET NAVIGATION AT LOWEST WATER.

The field-work of this survey was begun in the early part of September, and was continued until the end of December, when the rise of the river made it necessary to stop operations, as satisfactory results could not be had while there was so great a depth of water over the obstructions.

The instructions to this party were that they should not attempt to make a continuous survey of the river, but, beginning at Knoxville, they should descend the river, sounding as they went, and wherever they found a place where the depth in the channel would be at the lowest known

stage of water less than 3 feet, they should stop and make a survey of it sufficiently in detail to permit the preparation of estimates for gaining the desired depth.

A continuous survey of the river from Knoxville to the Alabama State line had been made by the General Government in 1832, but the shoals and bars had altered so much in the intervening period that the maps were useless as a basis upon which to form plans and estimates for making the necessary improvements.

During the interval from September to December, when operations ceased for the winter, surveys were made of—

1. *Knoxville Shoals*, at Knoxville, sixty miles by river above Loudon.
2. *Lyon's Shoals*, seven miles below Knoxville.
3. *Williams's Shoal*, nine miles below Knoxville.
4. *Little River Shoals*, twelve miles below Knoxville.
5. *Post-Oak Shoals*.
6. *Russell's Shoals*, twenty-seven miles below Knoxville.
7. *Concord Shoals* (Rogers's Island).
8. *Chota Island Shoals*, thirty-eight miles below Knoxville.
9. *Coulter's Island Shoals*, thirty-nine miles below Knoxville.
10. *Sister Island Shoals*, forty-two miles below Knoxville.
11. *Williams's Bar*.
12. *Bustle's Bar*, forty-five miles below Knoxville.
13. *Belle Canton Shoals*, forty-six miles below Knoxville.
14. *Lenoir's Shoals*.
15. *Browder's* or *Bouder's Shoals*, fifty miles below Knoxville.
16. *Rock-Quarry Bar*.

Besides these surveys, examinations were made of many intermediate gravel-bars, where small amounts of dredging may be required in order to put the channel in the best condition, but where the insignificance of the obstructions rendered it unnecessary to undertake a survey.

In order to secure such information concerning the changes in the river as would be required in making up a perfect scheme for its improvement, water-gauges were established at Knoxville, Loudon, Kingston, and Chattanooga.

In March, 1875, a heavy flood, caused by excessive rains and the melting of the snow in the mountains, occurred in the Tennessee Valley. All the bottom-lands along the river were submerged, and at Chattanooga the water rose 51½ feet above low-water, overflowing one half the city, and driving the inhabitants to the high grounds. The water extended from the left bank of the river back to Missionary Ridge; the only part of the included area which remained above the surface being the two hills next the river, which lie within the city limits. The water rose to within 2½ feet of the height attained by the flood of 1867, breaking all the railroad and telegraph lines, and cutting the town off from any but water communication with the rest of the world for a week.

As there had never been any authentic data obtained concerning previous floods in the Tennessee, I decided to take advantage of the opportunity afforded by this one to gather all the information concerning it that I could, and accordingly I directed the party which had been engaged the preceding season in surveying the Tennessee, instead of resuming their work at Loudon, where they had left off, to begin at the mouth of Chickamauga Creek, six miles above Chattanooga, and to carry the survey to Bridgeport, taking frequent cross-sections of the space which had been submerged; and at the same time I directed cross-sections of the river, at its highest stage, to be taken at Knoxville, Loudon, Kingston, and Chattanooga, Tenn.; Bridgeport, Guntersville,

Decatur, and Florence, Ala.; Johnsonville, Tenn.; and Paducah, Ky. This was done after the waters had subsided, but while the marks left by it were still quite fresh, so that there was no difficulty in establishing the height to which it had risen at each point.

When these examinations were closed, as it would have been too costly to tow the surveying-boats back to London, the party was directed to continue their survey of the river from Bridgeport down as they had conducted it from Knoxville to Loudon, it being intended to fill the break in the survey from Loudon to Chickamauga Creek when sufficient additional funds should be obtained for the purpose. At the close of the fiscal year the funds were nearly exhausted, and at the end of July they were entirely expended; and the survey having nearly reached Guntersville, the party was disbanded, and the boats laid up at that place until further means for prosecuting the survey should be obtained.

The importance of completing this survey of the Tennessee River cannot be overestimated, as it is absolutely essential to the formation of correct estimates of the cost of improving this river.

All estimates for improvements heretofore made have been based upon the results of examinations made with such inadequate means that they deserve rather to be designated as reconnaissances than as examinations for improvements.

The work of actual survey has now been carried over about one-quarter of the river's length, and to complete it in a satisfactory manner will require an appropriation of $30,000, which I earnestly recommend.

2.—SURVEY OF THE COOSA, OCMULGEE, AND ALTAMAHA RIVERS.

As heretofore stated, these were surveys of portions of the "proposed line of water communication from the Mississippi River to the Atlantic Ocean by way of the Tennessee River," which had never been surveyed, and the estimates for whose improvement had been made up from the known lengths of the parts of the rivers under consideration, and from the average cost per mile of the improvement of rivers of the same general character as these. (See report of the Chief of Engineers for 1872, page 509.)

COOSA RIVER, FROM ROME, GA., TO THE MOUTH OF WILL'S CREEK, TWO MILES AND A HALF BELOW GADSDEN, ALA.

This constitutes the *Coosa division* of the proposed water line, and in the report just referred to its length is given as one hundred and fifty-three and a half miles, the distance from Rome to Gadsden being usually regarded as one hundred and fifty-one miles. The usual authorities for these distances are the steamboatmen and others employed upon the river, who are in the habit of passing up and down it; but they are authorities that can seldom be relied upon, for we have found in our examinations that these distances are almost always overestimated. For instance, steamboatmen on the Lower Tennessee to this day claim that the distance by river from Florence, Ala., to Paducah, Ky., is from two hundred and ninety to three hundred miles, when, by actual survey made by a Coast Survey party during the war, the distance was found to be only two hundred and fifty-five miles, a reduction of from one-sixth to one-eighth below the estimated distance.

Measurements made from the ordinary maps, on the contrary, almost invariably give results much too small. It was found while making the canal survey through Georgia, in 1872, that the lengths of the streams,

as determined by actual survey, were from 15 to 20 per cent. greater than their lengths as obtained by the closest measurements on the maps. The error of ordinary map measurement, of course, results from the disappearance of curves in reducing the scale of the map; the map measurement giving the length of chords instead of the lengths of the corresponding arcs. Thus in a large State map, drawn six miles to the inch, a curve of 120° a mile long would not differ perceptibly from its chord, the versed sine being one twenty-fourth of an inch, while the actual loss of distance in plotting would be about one-sixth of a mile. The difference with smaller distances or lesser curves would disappear entirely. Mr. Frobel, who conducted the examination of the Coosa River from Rome to the mouth of Will's Creek, calls the distance one hundred and twenty miles, determined by map measurement, thirty-three miles less than the distance given by the steamboatmen. As the error in either method of measurement is always of the same kind, the steamboat measurement being always too large, while the map measurement is always too small, it is fair perhaps to take an average of the two, which would make the distance from Rome to the mouth of Will's Creek one hundred and thirty-seven miles.

The party under Mr. Frobel took the field in October, and reached Gadsden on the 10th of December, having sounded out 51 shoals which required improvement in order to secure 4 feet depth over them at low water, and having examined five bars which required no improvement. Mr. Frobel's report and estimate are given below. In regard to his estimate, I am of the opinion that it is much too small. The rates which he gives, viz, $1 per cubic yard for the removal of gravel and loose rock, and $3 per cubic yard for the excavation of solid rock, would no doubt be sufficient if the work were concentrated so that the labor might be organized in the best manner; but by reference to the description, it will be seen that the amount of work to be done at each of these 51 points, scattered over a distance of one hundred and thirty-seven miles, is very small, and I do not think it can be done for less than double the amount of his estimate, or—

	$150,000 00
To which adding 20 per cent. for contingencies	30,000 00
Total	180,000 00

This is for a depth at low water of 4 feet. For a depth of 3 feet at the same stage, the cost would probably be not more than half this amount.

REPORT OF MR. B. W. FROBEL, ASSISTANT ENGINEER.

MACON, GA., *January* 11, 1875.

MAJOR: I have the honor to lay before you the report of an examination and survey of that portion of the Coosa River between the city of Rome and the mouth of Great Will's Creek, made in compliance with instructions received from you on the 18th of September last.

On the 18th day of October we began the survey at the junction of the Etowah and Oostenaula Rivers, immediately below the city of Rome. General Eugene Le Hardy, a distinguished civil engineer, gives the elevation of low water mark at this point, above mean low tide in Mobile Bay, at 590.80 feet, and low water at the mouth of Will's Creek at 528.30 feet; making the difference of level between the points indicated 62.50 feet. This gives an average fall of .520 feet per mile. Deducting the fall at Horse Leg and other shoals, we have .390 feet per mile as the average fall of that portion of the river which is free from shoals. According to the land surveys made by the State of Georgia, and the United States land surveys in Alabama, the distance from Rome to the mouth of Will's Creek is about one hundred and twenty miles. Great

care was taken during the progress of the survey to determine the correctness of the land-maps, so far, at least, as the location of the river is concerned, and with satisfactory results.

The names of the different bars and shoals, together with the amount and estimated cost of work necessary to give a channel 80 feet wide and 4 feet deep at extreme low-water, will be found in the inclosed statement. The general map which accompanies this gives the location of each obstruction accurately, while the detail-maps show the cross-section soundings, and the kind and extent of each obstacle, and the work required for its removal. This, with one exception, consists in excavation, and the removal of loose rocks from the channel. The exception will be found at Horse Leg Shoal, one mile below Rome. The river-bed at this point is solid limestone rock, partially overlaid by a thin layer of gravel. Over this rocky bed there is a fall of 3.68 feet in a distance of 3,000 feet, and upon the upper and lower reefs a depth of 22 inches at "dead low-water." This depth is somewhat increased by wing-dams, but these increase the velocity also, and make it impossible for steamboats to ascend without the aid of warps. For some three months in the year this shoal seriously interferes with the free navigation of the river. At other times it has an average depth of water varying from 4 to 6 feet, and all difficulty in passing it disappears. Between the upper and lower reefs the channel is divided by a small island; the lesser channel, on the left, being about 100 feet wide. In this passage, at low-water, 3 feet may be found. Some years ago an effort was made to improve this channel by building a dam across the main channel at the head of the island, but this resulted in obstructing with drift the outlet at the lower end of the island, and had to be abandoned. The dam was removed and one built across the lesser channel. By removing this and putting a dam across the chute at the lower end of the island, with a lock of 3 feet lift, from 5 to 6 feet of water may be had at all seasons through this pass-way. This would relieve the difficulty at low-water without obstructing the main channel at other times. With the exceptions given in the statement, the river is free from obstruction between Rome and Will's Creek, and has a depth at low-water varying from 7 to 28 feet. Its regimen is fixed with banks not subject to wash or slide, and the pilots tell me there has been no perceptible change in its bed for the past twenty years. The extreme difference between high and low water at Rome is 29 feet, and at Gadsden 28 feet; but these extremes are not reached oftener than once a year, and sometimes several years intervene.

Forming an important link in the proposed water communication between the West and the Atlantic seaboard, through the Cotton States, this river is of infinite value to the inland navigation of the country. But apart from this, its local trade is sufficient to commend it to the favorable consideration of the government. The census of 1870 gives the following values, in the counties watered by the Coosa River and its navigable tributaries:

Population	591,670
Acres improved land	2,609,494
Acres unimproved land	6,285,494
Annual value of farm-products	$44,330,125
Bales of cotton	230,477

Add to this the vast beds of iron and coal, which are now valueless because they have no outlet to a market, and we have the strongest possible argument in favor of the work. For twenty-five years this portion of the Coosa has been navigable by steamers of two or three hundred tons burden. During this period there has been no accident, and, although these boats could descend the river no farther than Greensport, yet I am informed by many persons living in this section that their lands have more than doubled in value since these steamers were put on the river. The iron of this region is superior, not only for mechanical purposes, but for all kinds of ordnance, and the only thing in the way of a successful development of that interest is the want of transportation. Give this iron and coal an outlet, and they alone would repay a hundred-fold the cost of opening the Coosa.

I am greatly indebted to my assistants, Messrs. W. B. Gwynn and H. M. Smith, for valuable services rendered by them during the survey.

I am, major, very respectfully, your obedient servant,

B. W. FROBEL,
Civil Engineer.

Maj. WALTER MCFARLAND,
Corps of Engineers, U. S. A.

ESTIMATE FOR THE IMPROVEMENT OF THE COOSA RIVER FROM ROME, GA., TO THE MOUTH OF GREAT WILLS CREEK, ALA., ONE HUNDRED AND TWENTY MILES, TO GIVE A CHANNEL 80 FEET WIDE AND A DEPTH OF 4 FEET WATER AT EXTREME LOW STAGE.

The dam to be crib-work, with timbers 14 inches in diameter, filled with heavy rock, and doubly planked with 2-inch plank. The headings and tailings of the lock of masonry laid in cement, and the lock-chambers of crib-work, of the same construction as the dam. Lock to be 200 feet between miter-sills, and 32 feet wide.

1. One-eighth of a mile below Rome is Mills's Bar; river, 330 feet wide; bar, 300 feet long; gravel.

206 cubic yards gravel excavation, at $1	$206

Water from city to bar from 7 to 10 feet.

2. Seven-eighths of a mile below Mills's Bar is Horse Leg Shoal; river, 394 feet wide at head of shoal, and 375 feet at foot; shoal, 3,000 feet long, solid rock, overlaid partially with gravel.

Gravel-excavation, 3,354 cubic yards, at $1	3,354
Loose-rock excavation, 213 cubic yards, at $1	213
70-foot dam, at $12 per linear foot	840
Lock, 3-foot lift	7,000

Water from Mills's Bar to Horse Leg, 7 to 10 feet.

3. One mile and a half below Horse Leg is Shorter's Island; river, 200 feet wide; bar, 723 feet long.

Gravel-excavation, 1,332 cubic yards, at $1	1,332

Water from Horse Leg to Shorter's Island, 7 to 10 feet.

4. One-half mile below Shorter's Island is Loose Rock Bar.

This consists of loose rock in mid-channel.

Excavation, 25 cubic yards, at $1	25

5. One mile and a fourth below Loose Rock Bar is Bluff Road Bar; river, 320 feet wide; bar, 300 feet long; gravel.

Gravel-excavation, 889 cubic yards, at $1	889

Water from Loose Rock Bar to Bluff Road from 5 to 17 feet.

6. One mile and a fourth below Bluff Road Bar is Mayo's Bar; river, 300 feet wide; bar, 300 feet long; gravel.

Gravel-excavation, 623 cubic yards, at $1	623

7. One mile and three-fourths below Mayo's Bar is Rixey's Bar; river, 200 feet wide; bar, 154 feet long; gravel.

Gravel-excavation, 339 cubic yards, at $1	339

Water from Mayo's Bar to Rixey's, 5 to 8 feet.

8. One mile and a half below Rixey's is Price's Upper Bar; river, 300 feet wide; bar, 100 feet long; gravel.

Gravel-excavation, 184 cubic yards, at $1	184

9. One-half mile below Price's Upper Bar is Price's Lower Bar; river, 300 feet wide; bar, 100 feet long; gravel.

Gravel-excavation, 179 cubic yards, at $1	179

Water between upper and lower bars, 6 to 8 feet.

10. One mile and a fourth below Price's Lower Bar is Gould's Bar; river, 300 feet wide; bar, 100 feet long; gravel.

Gravel-excavation, 164 cubic yards, at $1	164

Water between Price's Lower and Gould's Bar is 7 to 10 feet.

11. Two miles and a fourth below Gould's Bar is Palestine Bar; river, 290 feet wide; bar, 100 feet long; gravel.

Gravel-excavation, 178 cubic yards, at $1	178

Water between Gould's and Palestine, 7 to 10 feet.

12. One mile and a half below Palestine Bar is Beech Creek Bar; river, 320 feet wide; bar, 230 feet long; gravel.

Gravel-excavation, 330 cubic yards, at $1	330

Water between Palestine and Beech Creek, 7 to 10 feet.

13. Two miles and three-fourths below Beech Creek is Quinn's Island Bar; river, 170 feet wide; bar, 300 feet long; gravel.

Gravel-excavation, 328 cubic yards, at $1 .... $328

Water between Beech Creek and Quinn's Island is 7 to 13 feet.

14. Three-fourths of a mile below Quinn's Island is Cathey's Bar; river, 290 feet wide; bar, 200 feet long; gravel.

Gravel-excavation, 178 cubic yards, at $1 178

Water between Quinn's Island and Cathey's, 5 to 7 feet.

15. Four miles and one-eighth below Cathey's is Dean's Upper Bar; river, 310 feet wide; bar, 215 feet long; gravel.

Gravel-excavation, 340 cubic yards, at $1 340

Water between Cathey's and Dean's, 5 to 12 feet.

16. One-half mile below Dean's Upper Bar is Dean's Lower Bar; river, 310 feet wide; bar, 220 feet long; gravel.

Gravel-excavation, 401 cubic yards, at $1 401

Water between upper and lower bars, 5 to 7 feet.

17. Three miles and five-eighths below Dean's Lower Bar is Foster's Upper Island Bar; river, 230 feet wide; bar, 250 feet long; gravel.

Gravel excavation, 956 cubic yards, at $1 956

Water between Dean's and Foster's Island is 6 to 15 feet.

18. Two hundred yards below Foster's Upper Island is Foster's Lower Island; river, 200 feet wide; bar, 800 feet long; gravel.

Gravel-excavation, 2,891 cubic yards, at $1 2,891

Water between these islands, from 4 to 7 feet.

19. One mile and a half below Foster's Lower Island is Copperas Bluff Shoal; river, 250 feet wide; bar, 4,200 feet long; gravel, shaly, slate, and calcareous spar.

Gravel-excavation, 292 cubic yards, at $1 292
Slate and spar excavation, 4,467 cubic yards, at $2 8,934

Water Between Foster's Island and Copperas Bluff, 5 to 9 feet.

20. Five miles and a half below Copperas Bluff is Kirkpatrick's Bar; river, 300 feet wide; bar, 100 feet long; gravel.

Gravel-excavation, 384 cubic yards, at $1 384

Water between Copperas Bluff and Kirkpatrick's is from 6 to 18 feet.

21. Three miles and a quarter below Kirkpatrick's Bar is Upper Mill Shoal; river, 320 feet wide; shoal, 3,200 feet long; gravel, slate, and calcareous spar.

Gravel-excavation, 731 cubic yards, at $1 731
Slate and spar excavation, 1,736 cubic yards, at $2 3,472

Water between Kirkpatrick's and Upper Mill Shoals, from 7 to 12 feet.

22. One-fourth of a mile below Upper Mill Shoal is Lower Mill Shoals; river, 300 feet wide; shoal, 2,100 feet long; sand and gravel.

Sand and gravel excavation, 7,893 cubic yards, at $1 7,893

Water between Upper and Lower Mill Shoals, from 5 to 8 feet.

23. Three-fourths of a mile below Lower Mill Shoal is McClellan's Island Bar; river, 180 feet wide between island and right bank; bar, 825 feet long; gravel.

Gravel-excavation, 104 cubic yards, at $1 104

Water between Mill Shoals and McClellan's Island, 5 to 12 feet.

24. One-half mile below McClellan's Bar is McCoy's Bar; river, 280 feet wide; bar, 600 feet long; gravel.

Gravel-excavation, 859 cubic yards, at $1 859

Water between McClellan's Island Bar and McCoy's Bar, 5 to 8 feet.

25. Two miles and a quarter below McCoy's Bar is Cothran's Ferry Bar; river, 300 feet wide; bar, 400 feet long; gravel.

Gravel-excavation, 296 cubic yards, at $1 296

Water between McCoy's and Cothran's Bars, 7 to 12 feet.

26. Three-fourths of a mile below Cothran's Ferry Bar is Middle Bank Bar; river, 320 feet wide; bar, 400 feet long; gravel.

Gravel-excavation, 476 cubic yards, at $1 .... $476

Water between Cothran's Ferry Bar and Middle Bank Bar, 6 to 12 feet.

27. Four miles and a half below Middle Bank Bar is Chicken Shoals; river, 260 feet wide; bar, 5,700 feet long; gravel, shale, and spar.

Gravel-excavation, 1,872 cubic yards, at $1 1,872
Slate and spar excavation, 4,394 cubic yards, at $2.................................. 8,788

Water between Middle Bank and Chicken Shoals from 5 to 14 feet.

28. One mile and a quarter below Chicken Shoals is Webb's Bar; river, 300 feet wide; bar, 300 feet long; gravel.

Gravel-excavation, 642 cubic yards, at $1 642

Water between Chicken Shoals and Webb's Bar, 6 to 12 feet.

29. One mile and a quarter below Webb's Bar is Angle's Bar; river, 290 feet wide; bar, 300 feet long; gravel.

Gravel-excavation, 135 cubic yards, at $1 135

Water between Webb's Bar and Angle's Bar is 8 to 12 feet.

30. One-half mile below Angle's Bar is Wester's Bar; river, 260 feet wide; bar, 1,900 feet long; gravel.

Gravel-excavation, 793 cubic yards, at $1.................................. 793

Water between Angle's and Wester's, 5 to 8 feet.

31. Eight miles and a half below Wester's Bar is Yellow Creek Bar; river, 300 feet wide; bar, 200 feet long; gravel.

Gravel-excavation, 196 cubic yards, at $1.................................. 196

Water between Wester's and Yellow Creek, 6 to 14 feet.

32. One mile and a half below Yellow Creek Bar is Mackey's Bar; river, 310 feet wide; bar, 200 feet long; gravel.

Gravel-excavation, 77 cubic yards, at $1.................................. 77

Water between Yellow Creek Bar and Mackey's Bar, from 7 to 14 feet.

33. One mile and one-fourth below Mackey's Bar is Fish-Trap Shoal; river, 340 feet wide; bar, 800 feet long; gravel.

Gravel-excavation, 1,259 cubic yards, at $1 1,259

Water between Mackey's and Fish-Trap, 8 to 14 feet.

34. Two miles and three-fourths below Fish-Trap Shoal is Chrisley's Island Bar; river, 200 feet wide; bar, 100 feet long; gravel.

Gravel-excavation, 70 cubic yards, at $1.................................. 70

Water between Fish-Trap Shoal and Chrisley's Island, 6 to 14 feet.

35. Two miles and three-fourths below Chrisley's Island Bar is Upper Center Island Bar; river, 300 feet wide; bar, 1,100 feet long; gravel.

Gravel-excavation, 631 cubic yards, at $1.................................. 631

Water between Chrisley's and Upper Center Island, 5 to 18 feet.

36. One-fourth of a mile below Upper Center Island Bar is bar; river, 350 feet wide; bar, 300 feet long.

Gravel-excavation, 106 cubic yards, at $1.................................. 106

Water between Upper Center Island Bar and this bar, from 5 to 7 feet.

37. One mile and a half below preceding bar is Lower Center Island Shoal; river, 280 feet wide; bar, 4,800 feet long; gravel, slate, and spar.

Gravel-excavation, 616 cubic yards, at $1.................................. 616
Slate and spar excavation, 1,139 cubic yards, at $2.................................. 2,278

Water between preceding bar and Lower Center Shoal, 6 to 12 feet.

38. Three miles and a half below Lower Center Shoal is Collier's Bar; river, 350 feet wide; bar, 400 feet long; gravel.

Gravel-excavation, 887 cubic yards, at $1 887

Water between Lower Center and Collier's, 5 to 10 feet.
39. One mile and a half below Collier's Bar is Wood's Rock Bar; river, 240 feet wide; bar, 300 feet long; slate and spar.

Slate and spar excavation, 41 cubic yards, at $2 .... $82

Water between Collier's and Wood's, 6 to 18 feet.
40. Four miles and three-fourths below Wood's Rock Bar is Davis's Bar; river, 400 feet wide; bar, 300 feet long; gravel.

Gravel-excavation, 680 cubic yards, at $1 680

Water between Wood's Rock Bar and Davis's Bar, 7 to 20 feet.
41. One mile and three-fourths below Davis's Bar is Auberry's Bar; river 320 feet wide; bar, 100 feet long; gravel.

Gravel excavation, 205 cubic yards, at $1 205

Water between Davis's and Auberry's, 5 to 14 feet.
42. Four miles and a half below Auberry's Bar is Ball Play Bar; river 390 feet wide; bar, 400 feet long; gravel.

Gravel-excavation, 2,049 cubic yards, at $1 2,049

Water between Auberry's and Ball Play is 4 to 15 feet.
43. Four miles and a half below Ball Play is Croft's Upper Island Bar; river, 280 feet wide; bar, 200 feet long; gravel and rock.

Gravel-excavation, 412 cubic yards, at $1 412
Rock-excavation, 412 cubic yards, at $3 1,236

Water between Ball Play and Croft's Upper Island, 5 to 14 feet.
44. One fourth of a mile below Croft's Upper Island Bar is Croft's Lower Island Bar; river, 300 feet wide; bar, 1,200 feet long; gravel.

Gravel-excavation, 2,665 cubic yards, at $1 2,665

Water between Upper and Lower Islands, 4 to 5 feet.
45. Three miles and a quarter below Croft's Lower Island Bar is "Thin Water," above Wagnan's wood-yard; river, 325 feet wide; "Thin Water" one-third of a mile long.

Gravel-excavation, 500 cubic yards, at $1 500

Water between Croft's Lower Island and Wagnan's, 5 to 14 feet.
46. Seven miles and a half below Wagnan's wood-yard is Tinsley's Island Bar; river, 170 feet wide; bar, 400 feet long; gravel.

Gravel-excavation, 563 cubic yards, at $1 563

Water between Wagnan's and Tinsley's Island, 5 to 15 feet.
47. One-half mile below Tinsley's Island is Turkey Town Island Bar; river, 390 feet wide; bar, 500 feet long; rock.

Rock-excavation, 612 cubic yards, at $3 1,836

Water between Tinsley's and Turkey Town, 5 to 14 feet.
48. Two miles and three-quarters below Turkey Town Bar is Berry's Ferry Bar; river, 400 feet wide; bar, 400 feet long; gravel.

Gravel-excavation, 201 cubic yards, at $1 201

Water between Turkey Town and Berry's Ferry Bars, 5 to 18 feet.
49. Two miles and three-fourths below Berry's Ferry Bar is a bar three-quarters of a mile above Hoke's Bluff; river, 380 feet wide; bar, 400 feet long; gravel.

Gravel-excavation, 166 cubic yards, at $1 106

Water between Berry's Ferry and this bar, 5 to 18 feet.
50. Three miles and three-quarters below preceding bar is Wesson's Island Bar; river, 370 feet wide; bar, 300 feet long; gravel.

Gravel-excavation, 295 cubic yards, at $1 295

Water from preceding bar, 5 to 25 feet.
51. Two miles and three-quarters below Wesson's Island is Cave Creek Bar; river, 300 feet wide; bar, 300 feet long; gravel.

Gravel-excavation, 33 cubic yards, at $1 33

Water between Wesson's Island and Cave Creek, 5 to 18 feet.

Removing snags and overhanging trees	$640
Total	74,254
Add 10 per cent. for contingencies	7,425
	81,679

The following bars were surveyed, but no work found necessary, viz: Duncan's, Ware's, McArrer's, Yancey's, and Will's Creek.

B. W. FROBEL,
Civil Engineer.

OCMULGEE AND ALTAMAHA RIVERS, FROM MACON, GA., TO DARIEN AND THENCE BY THE INSIDE PASSAGES TO SAVANNAH AND BRUNSWICK.

This is the *Altamaha division* of the proposed line of water-communication between the Mississippi River and the Atlantic Ocean, by way of the Tennessee River; and its length, following the river from Macon to Darien, is given as five hundred miles in the report upon this route contained in the Annual Report of the Chief of Engineers for 1872, page 509. As there stated, this is the distance usually accepted by steamboatmen and others engaged in the navigation of these rivers.

In conducting the examination of these rivers, the assistant, Mr. Frobel, attempted to determine this distance from the rate of speed of his boats, floating with the current, and from the length of their passage. Their rate, determined by means of base-lines on shore, he fixed at 162 feet per minute, while the actual time they were under way was 134 hours and 40 minutes, which would make the distance about two hundred and forty-eight miles, less than half that claimed by the river-men. But the sources of error in this method of measurement are too apparent to admit of its acceptance. It is impossible that the current of the river should maintain the same rate over its whole length, and at all hours; and an increase of from 40 to 80 feet per minute, which could not be observed, would make the distance from one-quarter to one-half longer than that given.

The railroad from Macon to Brunswick, which is a very straight and direct one, is one hundred and eighty-six miles long; and the river from Macon to Brunswick, which is very crooked, cannot be less than double this length, and is probably more. No reliance whatever can be placed upon this method of determining distance, unless the rate of progress for every hour of the passage is accurately known. As shown in speaking of the Coosa, the map measurements are invariably too little, while the steamboat measurements are much too large.

I do not doubt that five hundred miles is an overestimate of this distance, but I have as little doubt that the distance is somewhere about four hundred miles.

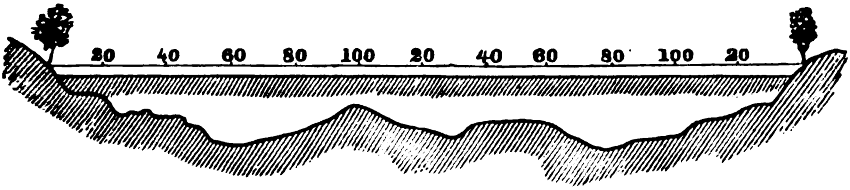
The examination of these rivers was begun at Macon about the 1st of January, 1875, and ended at Savannah on the 20th of February. In this interval surveys were made of 34 shoals and bars which require improvement. The following are extracts from Mr. Frobel's letters and reports upon the subject:

EXTRACTS.

* * * * * * *

In examining obstacles of a serious nature I used the same plan adopted for the Coosa. First, an accurate instrumental outline of the shore was taken. A rope, marked

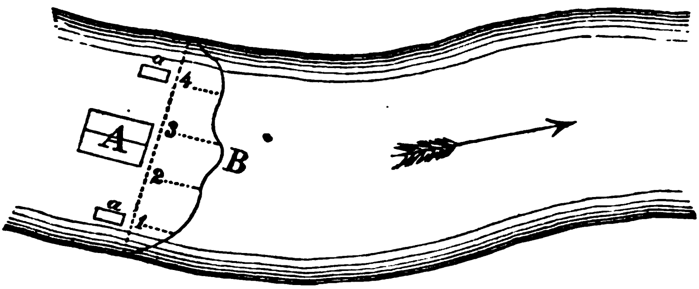
at intervals of 20 feet, was then stretched across the stream at each station, and soundings taken along it. This rope served to keep the sounding-boat in position, and enabled us to determine accurately not only the location of each sounding but the depth and character of the bottom as well. Thus, in the diagram, the shaded line represents the surface of the water, with the rope stretched above it. By this means an accurate



cross-section can be had of the bottom, however uneven, and the estimates made as close and with the same certainty as upon a measurement on dry land.

The whole river, from Macon to Darien, was sounded out. These soundings were taken at short intervals in the "reaches" or straight portions of the stream, and in every bend. Where the channel is tortuous they do not give the best water, as it was necessary to keep the boats on the "point" or shallow side, to avoid eddies. * * *

Where doubt existed as to the width or depth of the channel, soundings were taken as follows:



A, in diagram, represents the two larger boats lashed together side by side; *a a*, the smaller boats. At 1, 2, 3, and 4, rodmen were stationed, the boats were kept in line, and about 30 feet apart, and soundings taken together at intervals of 30 seconds. In this way a cross-section, as at B, could be had at intervals of 81 feet, and with soundings 30 feet apart, and where the bottom was of sand or mud, and tolerably uniform, with very great accuracy.

* * * * * * *

The point adopted as low water is *extreme low water*—the lowest point known to any pilot on the river. This extreme low point is only reached at intervals of several years, and then lasts but a short time. The usual gauge of the river, even in the dry season, is from 18 inches to 2 feet above it. This dry season begins in August, and usually ends in October.

Macon is 273 feet above mean low tide on the Atlantic coast. The river, from here to the sea, flows through a flat country, and for much of the way through swamps, varying in width from one-half to three miles. The banks are low and heavily timbered; the soil, being alluvial, washes readily, often undermining the trees which grow near the water's edge.

* * * * * * *

Between Hawkinsville and Macon the most formidable obstructions to navigation are the two bridges belonging to the Macon and Brunswick Railroad. The first of these bridges is nine miles below Macon, and its lower chord is only 14 feet above extreme low water. At the time we passed it was scarcely 9 feet above the surface of the river. This bridge effectually closes the river to steamboat navigation, and even to loaded flat-boats. The second bridge is at Hawkinsville. Its lower chord is 29 feet above extreme low water, and although not such an effectual barrier as the one near Macon, is still a formidable obstacle. Before the construction of these bridges boats ascended the river to Macon, and this has been the case in recent years.

From the mouth of the Altamaha there is an unobstructed inland navigation to Brunswick, with water sufficiently deep to accommodate vessels much larger than any that will be used upon the proposed canal. One route is down the south channel of the Altamaha to Altamaha Sound, and thence through Butter-Milk Sound and Frederica River into Saint Simon's Sound, which is Brunswick Harbor. The other route is through Darien River, which is the north channel of the Altamaha, to Three-mile Cut,

and through that into Altamaha Sound, and thence through Butter-Milk Sound and Frederica River to Brunswick. By the former route, the distance from the mouth of the Altamaha to Brunswick is twenty miles; by the latter, the distance from Darien is thirty miles. These routes are distinctly marked upon the accompanying map, as is also the inland passage to Savannah. This passage is down Darien River to Doboy Sound, across the sound and through New-Tea-Kettle Creek and Mud River into Sapelo Sound; from Sapelo Sound into South Newport River, through South Newport River and Johnston's Creek into North Newport River; thence by Walburg Creek into Saint Catharine's Sound; across the sound and up Bear River to Florida Passage, through this into the Ogeechee River, down this river and through Hell-gate into Adam's Creek; through this creek and Rommilly Marsh into Wilmington River, and up this river to the Savannah River, two miles below the city.

* * * * * * *

The bar at Savannah has on it at mean low water 19 feet, and at mean high water 26 feet. In Tybee Roads there is good anchorage at low water in 31 feet. The city is situated on the right bank of the river, about twenty miles from the bar. Vessels carrying 5,000 bales of cotton load at the wharves, and go to sea without difficulty. In 1873, the total arrivals and clearances at this port, foreign and coastwise, amounted to 1,130,304 tons. During the same year the imports amounted to $890,664, while the exports reached $29,850,275; and the total shipments, foreign and coastwise, $52,664,053.75. Between July 1, 1865, and July 1, 1873 (eight years), there was shipped from Savannah cotton alone whose value was $206,355,134. During the same period the imports amounted in value to $5,866,211, and the duties paid upon the same to $2,251,049.

Apart from the consideration of this river as a portion of the great proposed route between the East and the Mississippi Valley, when we consider the importance of its present trade, and the fact that the opening of it would directly affect (beneficially) thirty-six counties, and indirectly many more, we have the strongest argument possible in favor of the work. In these thirty-six counties there is a population of 323,626 souls. One million five hundred and fifty-eight thousand seven hundred and seven acres of land are cultivated, while 5,710,116 acres are lying waste. They produce annually 92,948 bales of cotton, while the aggregate of farm-products is $21,229,459. About 80,000,000 feet of lumber and timber also find their way to the sea through this river. The report of the Bureau of Commerce gives the entire export of sawed and hewed timber from the United States at $2,107,676. Of this amount, Georgia alone furnished $583,295, or something more than one-fourth of the entire export of the country.

A description of the obstructions to be met with in passing from Macon to Darien, with the estimated cost of removing them, so as to give 4 feet depth of water in the channel over them at the lowest stage of water, is appended hereto.

In regard to this estimate, I have the same remark to make that was made in relation to the Coosa estimate, viz: that although the prices assumed, viz, 60 cents per cubic yard for removing sand, $3 per cubic yard for excavating solid rock, and $10 apiece for removing snags, might be sufficient were the work to be done favorably situated for the purpose, yet, as this is not the case, the obstructions being scattered over a distance of perhaps four hundred miles, while but comparatively small amounts of work are to be done at each, I think that the cost of the improvement will be not less than double that given in the estimate,

Or about	$135,000
Adding 20 per cent. for contingencies	27,000
Total	162,000

SHOALS, SAND-BARS, AND OTHER OBSTRUCTIONS IN THE OCMULGEE AND ALTAMAHA RIVERS, WITH ESTIMATE OF COST AND AMOUNT OF WORK NECESSARY TO IMPROVE OR REMOVE THEM, SO AS TO GIVE A CHANNEL 80 FEET WIDE AND 4 FEET DEEP, AT EXTREME LOW WATER, BETWEEN THE CITY OF MACON AND DARIEN, GA.

1. *Upper Town Shoal.*—This is a small bar opposite the city of Macon and between the cemetery and county bridge. Its least depth of water is 4 feet, and needs no work.

2. *Lower Town Shoal.*—A sand-bar beginning just below the Central Railroad bridge and extending down the river to the Macon and Augusta Railroad crossing a distance

of 4,300 feet. This bar is caused in great part by sunken logs and trees. In its shallowest part, at extreme low-water, it has 22 inches. To give a channel 80 feet wide and 4 feet deep requires the removal of 16,171 cubic yards of sand.

3. *Gravelly Bar.*—This is a sand-bar about one mile below the Macon and Augusta Railroad bridge. It has sufficient water for boats drawing 3 feet, but the channel is narrow. To make it 80 feet wide requires the removal of 850 cubic yards of sand.

4. *Loggy Bight.*—There is 4 feet of water here. The only trouble is from logs which have lodged in the channel, compelling boats to keep the "shoal" or "point" side of the river. The logs are lodged in the best water.

5. *Public Turnip-patch.*—This has a depth of 4 feet, but, like Loggy Bight, is obstructed by fallen trees.

6. *Crocket's Bar* is about one mile below Gravelly Bar. The bottom is sand, with 4.80 feet at low-water. It needs no work.

7. *Evergreen Bar* is the next bar below Crocket's. It is a sand-bank, and requires 100 cubic yards of excavation to give the necessary width of channel.

8. *Lindsey's Bend.*—This bar has 4.20 feet at low-water, and needs no work.

9. *Green's Point.*—Soundings here indicate 9.20 feet at extreme low-water. No work needed.

10. *Quick Point* has 8.50 feet at dead low-water. No work is necessary here.

11. *Beasley's Shoal* is a rock reef extending partially across the river. Soundings indicate 5 feet at low-water, with more than 100 feet of channel.

12. *Taylor's Shoal.*—This is a sand-bar, and requires 1,917 cubic yards of excavation to give a channel 80 feet wide and 4 feet deep.

13. *Middle Shoal*, about one mile below Taylor's Shoal, is a sand-bar, and requires 1,049 cubic yards of excavation to give the necessary channel.

14. *Tan-yard Shoal* is about half a mile above Hawkinsville, and is of rock; 2,533 cubic yards of rock-excavation is needed to give a channel 80 feet wide and 4 feet deep.

15. *Hawkinsville Shoal* begins just below the railroad-bridge, and ends near the Hawkinsville Ferry. It is a rock-bar, and requires 373 cubic yards of excavation.

This includes all the shoals and obstructions between Macon and Hawkinsville except snags and logs and overhanging trees, and makes the following aggregate of cost on this portion of the river:

Sand-excavation, 20,087 cubic yards, at 60 cents	$12,052
Rock-excavation, 2,906 cubic yards, at $3	8,718
Snags and logs, 1,745, at $10 each	17,450
Willows and overhanging trees, 4,691, at $1	4,691
Total	42,911

The next shoal below Hawkinsville is—

16. *Henley's Shoal.*—This is of rock, and 100 cubic yards of excavation all that is needed.

17. *Grady's Shoal.*—A rock-reef extending part of the way across the river; 48 cubic yards of rock-excavation is needed here.

18. *Bracewell's Shoal.*—This is a rock-bar, but 4 feet can be carried over it at all times.

19. *Seven Sycamores* is also a rock-bar, but no obstruction to a vessel drawing 4 feet.

20. *Wilcox Shoal* is a rock-reef, but vessels drawing 4 feet can always pass it without difficulty.

21. *Loose Rock Shoals.*—Nos. 1, 2, and 3, sometimes called Indian Bluff Shoals. On these shoals there is at all times water sufficient for boats drawing 4 feet.

22. *Davis's Shoal.*—This is a loose-rock bar extending across the river, and requires the removal of 437 cubic yards of loose rock to give the requisite channel.

23. *Daniel's Shoal.*—There is one large rock here in mid-channel. Twenty cubic yards of rock-excavation is all that is needed.

24. *Atkins's Shoal.*—This is a loose-rock bar extending across the river. To give the required channel 346 cubic yards of loose rock must be removed.

25. *Stadum's Shoals.*—A rock-reef extending across the channel; 183 cubic yards of rock-excavation needed.

26. *Herbert's Shoal.*—There is a channel here at extreme low-water 4 feet deep and 75 feet wide. The shoal is part rock and part sand.

27. *Quinn's Shoal.*—This is a loose-rock bar, with 5 feet of water. Cutting off 75 feet of the point on the left bank of the river would greatly improve navigation here.

28. *Tiglman's Shoal.*—The obstruction here is sand and logs. There is 3 feet at low-water in the channel; but this could be increased to five feet by removing the logs.

The above are all the bars and shoals in the Ocmulgee between Hawkinsville and the mouth of the Oconee, and to give this portion of the river a channel 80 feet wide and 4 feet deep at extreme low-water will require the following work:

Solid-rock excavation, 351 cubic yards, at $3	$1,053
Loose-rock excavation, 883 cubic yards, at $2	1,766
Snags and logs (removal), 269, at $10 each	2,690
Overhanging trees (removal), 707, at $1	707
Removing 4 sunken rafts, at $500 each	2,000
	8,216

In Altamaha River we find the following bars and shoals:

29. *Town Bluff Shoal.*—This shoal is of sand and rock, but has at all times water sufficient for boats drawing 4 feet.

30. *Piney Bluff Shoal.*—This, also, has 4 feet at the lowest stage, and needs no work.

31. *Beard's Bluff Shoal* is a loose-rock and sand-bar, over which boats drawing 4 feet can always pass.

32. *Hell Shoal* is a loose-rock bar with 5 feet of water on it. It is between Piney Bluff and Beard's Bluff.

33. *Cooper's Bar.*—This is a sand-bar extending across the river after we reach tide-water. To give the required channel 7,777 cubic yards of sand-excavation is necessary

34. *Wood's Bar.*—This is the last obstruction on the Altamaha, and is situated about one-half mile above the city of Darien. Like Cooper's, it consists of a sand-bank reaching across the river, upon which there is not more than 3 feet at low-water. To give the required depth 5,037 cubic yards of sand must be removed. The following is a summary of the work needed on this division:

Sand-excavation, 12,814 cubic yards, at 60 cents	$7,688
Removal of snags and logs, 4, at $10 each	40
Total	7,728

RECAPITULATION.

First division, from Macon to Hawkinsville	42,911
Second division, from Hawkinsville to mouth of Oconee	8,216
Third division, from mouth of Oconee to Darien	7,728
Fourth division, from Darien to Brunswick	
Fifth division, from Darien to Savannah	
	58,855
Add 10 per cent. for contingencies	5,885
Total	64,740

This is all the work that is absolutely needed to give a safe navigation at all seasons of the year from Savannah, Brunswick, and Darien to Macon for boats drawing 3 or 4 feet. The channel could be greatly improved, however, by the following additional work, which should be done:

1. At *Cross Keys*, one mile below Durham's Bluff, Godwin's Cut-off should be cleaned out; this would cost	$653
2. At *Jay Bird Point*—75 feet of the point should be cut off; his will cost	414
3. At *Stephens's Bluff*, about the upper end, two points, one on either bank of the river, should be cut off 50 feet each; cost	553
4. At *Ragged Willow Point*—the trees should be cut here, and the point will wash away; cost	100
5. At the *Mouth of Big Indian Creek*—a point on either bank of the river should be cut away 50 feet each; cost	500
6. At *Sam Jones' Cut-off*—50 feet of the point on left bank should be cut off; cost	276
7. At *Cut-off* between Wild Boar Cut and wreck of steamer Comet, should be cleaned out; cost	540
8. Just above *Mitchell's Cut* a point on either bank should be cut away 50 feet; cost	500
9. At the mouth of *Cross Creek* the point should be cut off 50 feet; cost	100
10. *Henley's New Cut-off* should be cleaned out; cost	300
11. *Cut-off in Massey Log Bend* should be cleaned out; cost	1,500
12. *Turner's Point Cut-off* should be cleaned out; cost	100
13. *Point* below *Prigeon's Cut* should be cut away 50 feet; cost	275
14. *Rubin's Cut* should be cleaned out; cost	800

15. At *Quinn's Shoal* 75 feet of point on left bank should be cut off; cost...	$350
16. At *Little Hell*—four points should come off here, two on each bank; cost.	1,200
Total	8,161
Add to this the cost of excavation, &c	64,740
Grand total.	72,901

B. W. FROBEL,
Civil Engineer.

3.—SURVEY OF ROUTES FOR A FREIGHT-RAILWAY FROM THE TENNESSEE RIVER TO THE ALANTIC OCEAN.

In the report of the Senate Select Committee on Transportation-Routes to the Seaboard, recommending that a railway-route should be surveyed "from some convenient point on the Tennessee River, in Alabama or Tennessee, by the shortest and most practicable route, to the Atlantic Ocean," no mention was made of the gauges and grades which should be adopted for it. Upon examination of the ridge between the Tennessee and the Coosa, which it was thought would require the heaviest grades on the Guntersville route, it was found that the passage could be made with a maximum grade of one foot in a hundred, or 52.8 feet per mile, and this was adopted as the maximum grade for this line. The gauge was taken at 4 feet 8½ inches.

The same maximum grade was adopted for the Hiawassee route, but passing the Blue Ridge it was found necessary in several places to increase it to 66 feet per mile; while the line being but a link between other roads already constructed with the southern gauge of 5 feet, this was adopted as the proper gauge for this route. Both surveys provided for a double-track road.

THE GUNTERSVILLE ROUTE.

Mr. John E. Thomes, assistant engineer, of Chicago, Ill., was appointed to the charge of this survey. His instructions were to seek the shortest and most practicable route from Guntersville to the Atlantic coast at Brunswick or Savannah, Ga., the line to be run solely with a view to attaining the best engineering results, and without any regard whatever to the wants or claims of cities, towns, counties, corporations, or individuals as to its location.

His party took the field in September, 1874, beginning their survey at Guntersville, Ala., on the Tennessee River, at the starting-point of the canal-survey of 1872, and closed their field-work at Brunswick, Ga., at the end of May, 1875. Since then they have been engaged upon the maps and estimates, which are not yet completed, and Mr. Thomes's report will not be ready before November. The length of the line is four hundred and twelve miles. Beginning at Guntersville, it passes over Sand Mountain to Gadsden on the Coosa, crossing the Alabama and Chattanooga Railroad at Atalla, eighty-seven miles from Chattanooga; thence it runs easterly to Cross Plains, and passes through Terrapin Gap to the southerly side of the Dug Down Mountains.

The most important question which arose during the progress of this survey was the passage of these mountains, it being uncertain whether the line should be carried north of them and around their eastern end, or whether it should pass through them by means of one of the gaps. If it were to pass around the eastern end near Dallas, the line would approach Atlanta, and would probably reach Savannah as its

coast terminus. If it were to pass through the mountains more to the southward and westward, Brunswick would no doubt become the coast terminus.

This whole region was very carefully reconnoitered by Mr. Thomes, and a side party was organized for the purpose of running trail-lines with the level and transit through the practicable passes and around the mountain, in order to ascertain the route which offered the greatest advantages.

After a month's incessant work and study, it was found that the Terrapin Gap route offered the best results, and the line was accordingly run through it.

After leaving Terrapin Gap, the line takes a southeasterly course, and runs very directly to Brunswick, crossing the Tallapoosa River near Tallapoosa; the Chattahoochee, near and below the McIntosh Reserve; the Atlanta and West Point Railway, at a point five miles below Newnan, and forty-four miles southwest of Atlanta; the Flint River, between Erin and Texas; the Thomaston Railroad, near Union Hill, and the Macon and Southwestern Railroad, near Bateman, about twenty miles southwest of Macon; and the Ocmulgee River, first near Buzzard's Roost, and second at Lumber City. From Bateman to Brunswick the line runs parallel to and but a few miles south of the Macon and Brunswick Railroad.

The grades of this line are as follows:

	Miles.
Level	72.55
0 to 20	85.49
20 to 40	159.02
40 to 52.8	95.05
	412.11

It is Mr. Thomes's opinion that in locating this line it will not be necessary to make use of anything greater than a four-degree curve.

The line is not only entirely practicable, but it is an unusually favorable line for one of such length.

THE HIAWASSEE ROUTE.

This survey was placed in charge of Mr. James C. Anderson, assistant engineer, with instructions in regard to the location of the line similar to those given to Mr. Thomes. The survey was begun in September, 1874, at Charleston, Tenn., near the mouth of the Hiawassee River, at the crossing of the East Tennessee, Virginia and Georgia Railroad, and was carried up the Hiawassee Valley, and up the Hightower, one of its branches from the south, to and across the Blue Ridge, through Clayton, Ga., one hundred and twenty-five miles from the starting-point, to the partly-completed tunnel through Saddle Gap, two and a half miles beyond, on the line of the Blue Ridge Railroad. Another line was then started at a point on the first line, twelve miles west of Clayton, and was run in a southerly direction, crossing the Chattahoochee Ridge, to Wintersville, Ga., on the Athens branch of the Georgia Railroad, five miles east of Athens, eighty-five miles from the starting-point, and one hundred and ninety-eight miles from Charleston, on the Hiawassee. This completed the field-work of the survey, since which time the party has been engaged making the maps and estimates.

The first part of the line, from Charleston to the mouth of the Hightower, requires but light work, the grades being generally from 10 to 16 feet along the river, increasing to the adopted maximum grade of

52.8 feet at the crossing of some of the mountain-spurs which reach the river. A number of small tunnels will have to be made use of in passing these spurs, and one 7,000 feet long in passing the Blue Ridge.

After penetrating the Blue Ridge the descent on the eastern slope is so steep that the adopted maximum grade has to be exceeded, and one of 66 feet to the mile is made use of. This occurs again in crossing the Chattahoochee Ridge. It is possible, however, that in location both of these might be brought down to the 52.8-foot grade.

On the rest of the route the work is comparatively light.

The survey was not carried beyond Saddle Gap, on the Blue Ridge line, because that line of railroad to Anderson, S. C., had been already surveyed and partly built, and because there was no money to spare for a revision of its survey.

A large number of streams are crossed by this line, which involve altogether 20,350 linear feet of tunneling and 5,505 linear feet of bridging, though of a light character. Mr. Anderson thinks that in locating the line nothing greater than a 6° curve need be used.

The field-work of this survey was ended in May, 1875, but, although the office-work has been going on continuously ever since, Mr. Anderson's report will not be ready until November.

A table of grades is annexed.

Grades on first division from Charleston, Tenn., to first one-hundred-mile post.

	Miles.
Length of division	100.00
Length of level grade	14.56
Length of grades ascending eastward:	
From 0 to 10 feet per mile	20.36
From 10 to 20 feet per mile	29.03
From 20 to 30 feet per mile	10.21
From 30 to 40 feet per mile	4.55
From 40 to 50 feet per mile	2.80
Grade of 52.8 feet per mile	9.76
Total ascent 1,608.5 feet	76.71
Length of grades descending eastward:	
From 0 to 30 feet per mile	1.52
From 30 to 40 feet per mile	3.20
From 40 to 50 feet per mile	0.49
Grade of 52.8 feet per mile	3.52
Total descent 340.5 feet	8.73

Sum of ascent and descent, 1,949 feet. Average grade per mile, 19.49 feet. Curvature, 10.730° 57′. Length of curve, 45.16 miles. Per cent. of curve, 45.16. Per cent. of straight line, 54.84.

Grades on second division, from first one-hundred-mile post to Belton, Ga.

	Miles.
Length of division	55.00
Length of level grade	5.11
Length of grades ascending eastward:	
From 0 to 20 feet per mile	3.69
From 20 to 40 feet per mile	3.75
From 40 to 50 feet per mile	2.43
Grades of 52.8 feet per mile	4.89
Grades of 58 feet per mile	2.40
Grades of 66 feet per mile	2.84
Total ascent 880 feet	20.00

Length of grades descending eastward:

	Miles.
From 0 to 20 feet per mile	1.73
From 20 to 40 feet per mile	3.99
From 40 to 50 feet per mile	2.14
Grades of 52.8 feet per mile	10.98
Grades of 58 feet per mile	2.54
Grades of 66 feet per mile	8.51
Total descent 1,525 feet	29.89

Sum of ascent and descent, 2,405 feet. Average grade per mile, 43.73 feet. Curvature, 8.653° 14′. Length of curve line, 36.3 miles. Length of straight line, 18.7 miles. Percentage of curvature, 66. Percentage of straight line, 34.

Grades on third division from Belton to Wintersville, Ga.

	Miles.
Length of division	43.03
Length of level grade	8.33

Length of grades ascending eastward:

From 0 to 10 feet per mile	0.00
From 10 to 20 feet per mile	1.00
From 20 to 30 feet per mile	1.63
From 30 to 40 feet per mile	3.32
From 40 to 50 feet per mile	1.81
Grades of 52.8 feet per mile	4.52
Total ascent 482 feet	12.28

Length of grades descending eastward:

From 0 to 10 feet per mile	1.00
From 10 to 20 feet per mile	1.15
From 20 to 30 feet per mile	2.31
From 30 to 40 feet per mile	3.73
From 40 to 50 feet per mile	3.32
Grades of 52.8 feet per mile	6.60
Grades of 66 feet per mile	4.31
Total descent 1,004 feet	22.42

Sum of ascent and descent, 1,486 feet. Average grade per mile, 34.53 feet. Curvature, 2.204°. Length of curve, 10.43 miles. Length of straight line, 32.60 miles. Percentage of curve, 24½. Percentage of straight line, 75½.

Grades on Clayton division, from deflection from main line at the one hundred and thirteenth mile-post to connection with Blue Ridge Railroad at Saddle Tunnel.

	Miles.
Length of division	14.29
Length of level grade	2.13

Length of grades ascending eastward:

From 30 to 40 feet per mile	0.39
From 40 to 50 feet per mile	0.68
Grade of 52.8 feet per mile	5.53
Total ascent 336 feet	6.60

Length of grades descending eastward:

Grade of 52.8 feet per mile	2.31
Grade of 66 feet per mile	3.25
Total descent 337 feet	5.56

Sum of ascent and descent, 673 feet. Average grade per mile, 47.09 feet. Curvature, 2.343°. Length of curve line, 9.86 miles. Length of straight line, 4.43 miles. Percentage of curve, 69. Percentage of straight line, 31.

APPENDIX T 2.

FIRST SUBDIVISION OF THE NORTHERN TRANSPORTATION-ROUTE.

REPORT OF MAJOR G. K. WARREN, CORPS OF ENGINEERS, UPON THE IMPROVEMENT OF THE WATER-TRANSPORTATION ROUTE FROM THE MISSISSIPPI TO LAKE MICHIGAN, ALONG THE WISCONSIN AND FOX RIVERS.*

OFFICE OF THE CHIEF OF ENGINEERS,
Washington, D. C., February 11, 1876.

SIR: I transmit herewith the final report of Maj. G. K. Warren, Corps of Engineers, on the improvement of the route of water-transportation between the Mississippi River and Lake Michigan along the valleys of the Fox and Wisconsin Rivers, but more especially relating to the part along the Wisconsin.

Examinations were made in 1866 and instrumental surveys during 1867, and some minor ones in 1868 and 1869. The causes of delay in presenting this report will be found stated in it.

The improvement of this route is now in charge of Maj. D. C. Houston, Corps of Engineers. It forms part of the northern transportation-route between the interior and the seaboard, which was directed to be reported upon by the act approved June 23, 1874. Major Houston reports:

> The survey of the Wisconsin River, under the direction of Major Warren, in 1867, contains all the information bearing upon the subject, so far as a survey can determine it.

This is the survey now finally reported upon; it is the only survey of the river between Portage and the mouth that has ever been made, and the maps have not been published.

The publication of these maps and report now will supply information required by the act first authorizing it, as well as the more recent one of 1874. This report closes with the year 1869.

Major Warren has long been connected with western and eastern river improvements, and his presentation of the subject is intended to bring out views regarding the improvement of shallow rivers of considerable slope, small volume, and movable bed.

The conclusions reached by Major Warren are adverse to the permanent improvement of the Wisconsin River by a system of canalization or rectification of its low and high water channels, and that a canal along its banks is the only method of permanent improvement.

A plan of operations, with detailed estimates of cost, is given for the construction of a canal from Portage to the mouth, of the capacity of the Fox River improvements, for $4,000,000, in the space of two years.

He is of opinion, however, that a larger capacity should be adopted, and recommends location-surveys to be made to determine the best line for the improvement, as soon as the requisite capacity is decided upon. Breadth of canal and locks rather than depth is held to be the ruling idea in a canal adequate to steam-navigation, because the depth at low water on the Upper Mississippi must always be limited. A transfer at some point in the way to the seaboard will be necessary, and as the lake-vessels require depth, this transfer should be made at Green Bay, the canal being adapted to the navigation of the steamboats and barges of the Upper Mississippi.

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* Printed as Sen. Ex. Doc. No. 28, 44th Congress, 1st session.

The maps and diagrams are not numerous, and have been prepared with special view to the inexpensive photolithographic process, so that their publication with the report is recommended.

The present method of improvement of the Wisconsin is on trial on its own merits, and it is too soon for the department to announce the final result, but the publication of this report, with the data it contains, will enable others to form an opinion of the nature of the undertaking, and aid in a more speedy solution.

Very respectfully, your obedient servant,

A. A. HUMPHREYS,
Brig. Gen. and Chief of Engineers.

Hon. W. W. BELKNAP,
Secretary of War.

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ILLUSTRATIONS.

Two wood-cuts and nine photolithographic sketches, to accompany letter-press.

MAPS AND DIAGRAMS.

PLATE 1. General map and profile of the route, showing also the outlines of sheets 1 to 8, inclusive, on a larger scale.

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LETTER OF TRANSMITTAL.

ENGINEER OFFICE, UNITED STATES ARMY,
Newport, R. I., November 26, 1875.

GENERAL: I have the honor to transmit herewith my final report on the transportation-route along the Fox and Wisconsin Rivers, but more especially relating to the latter stream.

The text of the report is divided into five chapters, each of which, while forming a component part, is intended to be nearly complete in itself.

Chapter I is a brief account of my different occupations since I took up this subject in 1866 down to the present year. This appears to me called for by the length of time taken. It also furnishes a means of ready reference to any of the reports of the numerous other works on which I have been engaged during this same period.

Chapter II is an account of the early history of the route, which has special interest from its being the pathway to the discovery of the vast Mississippi Valley, and as in a measure certifying to its natural advantages, by showing that it was the first one to open the great Northwest to white men.

Chapter III is a chronological account of all improvements of the route from the first beginnings down to 1870, compiled from all available sources. The cost and condition of the works, as nearly as could be ascertained, is given from year to year; also, extracts from the laws, and estimates of cost of different kinds of improvement as designed by different engineers.

Chapter IV is an account of the surveys made by and under my direction in 1867, '68, '69, and of the maps and diagrams prepared. It contains a description of the river and valley and of all the features that influence one's appreciation of the question of navigation. In this chapter are tables of all the hydraulic data obtained from the measurements of the survey. It concludes with an account of some anomalous physical features along the route, and of the former expanse of Lake Winnebago, suggesting changes similar to what I have shown to have taken place in regard to Lake Winnepeg, in British America.

Chapter V is a presentation of the subject of improving the route for transportation along the valley of the Wisconsin, and no pains or effort has been spared to make this as complete and decisive as possible. It is shown here that any improvement in the natural bed of the river, intended to secure such commodious channel of navigation as the country desires, is impracticable.

The subject of canalization of the river is treated of at length. The extent and uncertainty of the time required, and the great cost and uncertainty at best of final success, condemn it. The plans of having reservoirs at the sources, or of making slackwater navigation by dams and locks, are shown to be impracticable.

A canal along the valley is the only resource, and a provisional location for one is made, with a detailed estimate of the cost of constructing it, if made of the same character and capacity as the present locks along the Lower Fox River. This estimate amounts to $4,000,000, and the time required to complete it is two years, if pushed with all practicable dispatch.

The feasibility of a canal of moderate expense being established, while no other plan seems practicable in my judgment, justifies urging an immediat and thorough survey for determining the route best for the canal. This survey should have in view the selection of the best route for a canal of the capacity of the existing improvement on the Lower Fox River, and also for such a more capacious channel as may be needed in the proximate future when the through route shall have become established.

The report is so divided into chapters, with tables of contents, that it will be unnecessary to read it all, unless the reader desires information upon all of the general subjects into which the chapters divide it.

To facilitate the presentation of the subjects, a few small plates of octavo size have been prepared for the text, if printed; and in this case the original map, scale of 2 miles to an inch, the general map and profile of the route from Green Bay to the Mississippi, and a diagram of river-gauge curves should be photolithographed.

I have in this report said nothing of the importance of the route as a line of water-transportation. Its importance is here taken as already well established. This matter was treated of by me in the annual report of the Chief of Engineers for 1868, pp. 357–359.

There are three appendixes to the report, which may be useful for reference, but which I do not think need to be published. A is a report of Assistant D. W. Wellman, from which I have taken part of the description of the valley in Chapter IV; B is the details of the estimates

of costs of canal-locks on the provisional canal location; C is the detailed specifications of the material and manner of constructing composite locks.

Very respectfully,

G. K. WARREN,
Maj. of Engineers and Bvt. Maj. Gen., U. S. Army.

Bvt. Maj. Gen. A. A. HUMPHREYS,
Brigadier-General and Chief of Engineers, U. S. A.

REPORT.

CHAPTER I.

AN EXPLANATION OF THE DELAY IN NOT SOONER COMPLETING THIS REPORT, BEING A GENERAL STATEMENT OF OCCUPATION ON PUBLIC DUTIES FROM 1866 TO 1874, INCLUSIVE.

In giving an account of the time taken by me in completing this final report on the improvement of the route of water-transportation along the Fox and Wisconsin Rivers (more particularly of the latter stream), it will be necessary to refer to the other work I have had to carry on at the same time, in order that a proper allowance may be made for the slow progress in this one. This duty was begun under the act of Congress making appropriations for certain river and harbor works approved June 23, 1866, and was assigned to me by instructions from the Chief of Engineers, United States Army, dated July 31, and August 2, following.

By these instructions my headquarters were established at Saint Paul, Minn., which place I reached early in August, and at once set to work to organize surveying and reconnoitering parties for the different works intrusted to me, and to gain the preliminary knowledge necessary to make proper organizations, and to properly equip and instruct them. It was a field remarkably free from acquired engineering data, so that while the acquisition of what was known was easy, it left nearly everything yet to be determined.

The duties assigned me, along with that which is the subject of this report, were to make "surveys and examinations," first "of the Mississippi River between Fort Snelling and the Falls of Saint Anthony, and the Upper or Rock Island Rapids of the Mississippi, with a view to ascertain the most feasible means of economizing the water of the stream, of insuring the passage at all navigable seasons of boats drawing 4 feet water;" second, "of the Minnesota River from its mouth to the Yellow Medicine River, in order to ascertain the practicability and expense, by slackwater navigation or otherwise, of securing the continued navigability of said stream during the usual season of navigation;" third, "of the Zumbro River, Minnesota;" fourth, "of the Cannon River, Minnesota;" fifth, "of the Fox and Wisconsin Rivers, in the State of Wisconsin;" sixth, "to examine and report upon the subject of constructing railroad-bridges across the Mississippi River between Saint Paul, in Minnesota, and Saint Louis, in the State of Missouri, upon such plans of construction as will offer the least impediment to navigation."

The act of Congress provided for a survey and examination of the Saint Croix River above the ledge, and as it was supposed the stream

referred to was the one forming part of the boundary between the States of Wisconsin and Minnesota, this was also intrusted to me. The examination, however, disclosed no such locality on this river as the "ledge," and it was afterward ascertained that the river designated in the act of Congress was the one forming part of the boundary between the State of Maine and the foreign province of New Brunswick, and I was relieved of further consideration of it.

My estimate of the cost of making these examinations, surveys, and reports was $70,000, but as they could not be made this season, and as the act of Congress required a report to be submitted at the next session, the work was laid out so as to gain a general knowledge of the whole field, at an estimated cost of $21,000, and thus comply, as far as practicable, with the law. It is unnecessary to state here any of the details of the different examinations, except that of the Fox and Wisconsin Rivers. For making this, about $2,000 was allotted, and it was given in charge of Bvt. Maj. Charles R. Suter, United States Engineers, with instructions as to the character of the examination to be made. I gave my personal attention almost entirely to the Mississippi between the Falls of Saint Anthony and Saint Louis, only examining the Wisconsin River at its junction with the Mississippi.

The results of all our work that season, as well as could then be exhibited, were given in my report dated January 21, 1867, printed as House Ex. Doc. No. 58, Thirty-ninth Congress, second session. In this report, pages 41 and 42, and pages 73 to 103, inclusive, relate entirely to the Fox and Wisconsin Rivers. A general map, on a scale of 6 miles to an inch, accompanying this report, was published at the office of the Chief of Engineers, United States Army, but it is not bound with the regular public documents, as published by Congress. This report was not reprinted in the succeeding annual report, as has been customary since; the important parts of it have therefore been incorporated in this report, in Chapter III. The examination of the Wisconsin River, in 1866, showed a necessity for a thorough survey of it, a thing which had never yet been done. This was duly reported, and an estimate of $15,000 was submitted for making such survey.

Progress made in 1867.—The act making appropriations for rivers and harbors, &c., was approved March 2, 1867. Before anything could be done on the Wisconsin I was employed, as a member of the Board of Engineers at Keokuk, Iowa, to report upon the plan of improving the navigation at the Des Moines Rapids of the Mississippi by means of a canal. This occupied me exclusively from March 22 to May 15, and on returning to Saint Paul preparations for making the survey of the Wisconsin were at once commenced, by setting up river-surface gauges and preparing quarter-boats, &c. There was an allotment of $40,000 made this year for conducting surveys on the Wisconsin River and Upper Mississippi River. There were also appropriations of $96,000 for building and operating two dredge and snag boats on the Mississippi; of $40,000 for one such boat on the Wisconsin River; and of $37,500 for removing snags and bowlders from the Minnesota River. The report we had rendered of the result of the examination of the Zumbro and Cannon Rivers failed to procure for them any appropriation from Congress.

The amount of work on my hands prevented my giving my personal attention to any one of them continuously, and the survey of the Wisconsin, from Portage City to its mouth, was placed in charge of Major Suter. High water prevented a commencement of the survey until August 26, and it was finished to the Mississippi River, a distance of

119 miles, on the 6th of November. An account of this survey will be given in another place. The dredge and snag boat for the Wisconsin River was not procured this year. The method of dredging proposed was to scrape the crest of the sand-bar down the stream, and, as the operations were in a measure experimental, it was thought best to limit these to the two boats on the Mississippi River. The smallest of these boats was unable to operate at the mouth of the Wisconsin, where she was tried, because of the very shoal water. Capt. D. W. Wellman, civil engineer, was however employed, out of the fund for this Wisconsin boat, to accompany the surveying party, and while aiding it, gain such knowledge as would enable him to best provide for the wants of navigation on that stream. Notwithstanding every effort that was made to make the survey-funds hold out, they became so exhausted that most of the assistants had to be discharged in December, before the notes were all plotted even in pencil. Captain Wellman and two assistants were retained, who continued the labor of plotting and constructing maps.

There was a brief annual report submitted by me September 14, 1867. (See Annual Report of Chief of Engineers of that year, pp. 259 to 263.) I also made a personal examination of the Wisconsin River, from the upper railroad-bridge down to the mouth.

Progress in 1868.—In January, 1868, Major Suter was relieved from duty with me, and I placed the completion of the maps in the hands of Captain Wellman, who continued the work, assisted by Messrs. Dukes and Rich. An additional allotment of $14,000 from the appropriation for surveys enabled me to continue the office-work on the Wisconsin maps, and also on those of the Mississippi.

On April 6, at the urgent solicitation of friends of the Wisconsin River improvement, I made a report of progress, which was printed as House Ex. Doc. No. 247, Fortieth Congress, second session. In that report the condition of the maps at that time is stated, and on p. 5 the importance of these river-surveys is treated of. (See also pp. 7 and 8.)

On April 18, 1868, I also made a report on the harbor of Alton, Ill. (See House Executive Document No. 257, Fortieth Congress, second session.)

The propositions which were about this time being urged in Congress to authorize the bridging of the Ohio River, at Bellaire and Parkersburg, caused my being sent for by the chairman of the Senate Committee on Post-Offices and Post-Roads, for consultation. This was owing to my having been engaged on the investigation of the general subject of bridging the Mississippi. I then went to Steubenville and surveyed the bridge across the Ohio at that place. The report of this, dated June 29, is included in the report of the committee dated July 16, printed as Senate Report No. 168, Fortieth Congress, second session. I aided in the preparation of the committee report, and the bill to regulate bridging the Ohio River submitted with it.

This session of Congress made no additional appropriation for surveys or completing maps, and that on hand was used to complete the plotting and construction of the maps in pencil, and to supply any omissions in the former field-work that became apparent when the notes were all worked up. The annual report, dated August 31, 1868, pages 301 to 305 of the printed Annual Report of the Chief of Engineers for 1868, gives the condition of the maps at that date. The field-notes had all been plotted on a scale of 200 feet to an inch, making twenty-four sheets, each 10 feet long. These had been reduced to a scale of two inches to a mile, but nearly everything was still in pencil.

On pages 351 to 363 is a comparison of several plans of improving the

Wisconsin River, which indicates that a canal, in part or whole of the distance along the valley, would be the most reliable one. It was seen from this that a special location-survey, to estimate the cost of a canal, was very desirable, but as there were no adequate funds for doing it, I was compelled to limit myself to making additional examinations and measurements, so as to define the outline of the foot of the bluffs and terraces, and obtain the approximate altitude of the terraces, where the survey had failed to do so. Some accurate additional information was obtained from the maps and profiles kindly furnished us by the officers of the Milwaukee and Saint Paul Railway Company. These additional examinations occupied Captain Wellman and one assistant during the autumn. I made a personal examination of the entire line of the Fox and Wisconsin route, and purchased the small steamboat Winneconne, to remove snags from the Wisconsin, but the water was too low to make any use of her that season.

The operations on the Mississippi and Minnesota Rivers, &c., gave me a good deal of work. (See Annual Report of Chief of Engineers for 1868, pp. 299 to 385, inclusive.) In addition, a survey of the battle-field of Gettysburg was begun under my direction, and early in October I was appointed one of a special commission to examine into the condition of the Union Pacific Railroad and the other branch lines east of the Rocky Mountains. Had I known the labor and time this was to take from me, I should have plead inability to perform it while retaining charge of my other works. We did not finish the work of this commission until December 11. I then returned to Saint Paul, where I was unable to attend to anything but the disbursements and similar matters.

Progress in 1869.—On January 15, I was made a member of the joint commission to examine the line of the Union Pacific and the California Central Railroads, to report upon their condition and point out the proper line on which the two roads should unite. The work on this commission occupied all my time in the field till April, and after that until May 15, in Washington, and the labor was very exhausting. The report was published by the Interior Department, but not generally distributed. When this labor ended, I was appointed commissioner to examine and report upon the five last completed sections of the Union Pacific Railroad; after doing which I returned to Saint Paul on July 14. Here I found a large accumulation of work requiring my attention, but had to at once leave it again to take charge of the construction of the bridge across the Mississippi at Rock Island. A curious complication of requirements had arisen here from incompatible conditions in the acts of Congress relating to the kind of bridge and its cost, or, at least, if not incompatible in reality, the authorized interpretation of the laws made them so. The attention of every one under my control was at once given to this matter to the exclusion of everything else, and by the 20th of September (the date of my annual report for 1869) a solution was reached as far as it was possible, and everything put in train for proceeding with the bridge in the way which it has since been completed. My connection with the Pacific Railroad commissions aided me very much at Rock Island, although both greatly interfered with the report on the Wisconsin, which is the occasion of their being mentioned here.

The Wisconsin River is again reported on by me in the printed Annual Report of the Chief of Engineers for 1869, pp. 190 and 191, my whole report occupying pp. 187 to 211, inclusive. I there recommend that $100,000 be appropriated to test the practicability of improving the navigation by wing-dams, before finally resorting to the project for a

canal, which my study and experience were leading me to, notwithstanding such plan found little favor with the public.

The office work on the maps was nearly suspended from June till November. Captain Wellman resurveyed the vicinity of the railroad-bridges to ascertain the changes in the river-bed at these places. He then submitted a general report, which closed his connection with the work.

In September and October, 1869, the Winneconne was employed removing snags and impending and fallen trees from the shores between Portage City and Sauk City. The obstructions thus removed are every year recurring, and the remedy is but a temporary one.

In October of this year I engaged Mr. Jacob Blickensderfer, an experienced canal-engineer, and together we examined the whole route along the Fox and Wisconsin Rivers, and afterward, with such data as we possessed, made an approximate location for a canal along the Wisconsin River, and prepared detailed estimates of cost of constructing it. A large force was now employed in inking and lettering the maps, but I could not take up the preparation of the final report, because of the necessity I was under of preparing a report, to be submitted to Congress, pointing out required modifications of the laws in regard to the Rock Island bridge before the building of the superstructure could be commenced. The data for this report had been obtained during the summer and autumn by my assistant, Major Benyaurd, United States Engineers, and I completed it on December 4. It is printed as House Executive Document No. 31, Forty-first Congress, second session. The remainder of December was employed in attending to the current office-business.

The other works carried on under me in 1869 were the operations of the dredge and snag boats on the Upper Mississippi, the survey and construction of map of the battle-field of Gettysburg, and the construction of a wagon-road from Duluth to the Bois-Fort Indian reservation.

Progress in 1870.—The winter at Saint Paul was one of unusual changes of temperature, the thermometer being frequently above the temperature of melting snow, so that affections of the throat and lungs became very prevalent. I was well worn out with the long-continued hard labor, and suffered so much from colds that I could do but little work in January. However, on the 12th, I made a brief report in regard to the Falls of Saint Anthony, which is printed as House Executive Document No. 118, Forty-first Congress, second session.

I finally was taken sick with pneumonia, which confined me to my bed nearly six weeks and left me in a very enfeebled condition. While I was sick the order came (General Orders No. 16, February 7, 1870), directing me to complete my reports, and not later than the first of April proceed to Detroit and take charge of the survey of the lakes. My health, however, would not permit me to do this, and at my request another officer was sent to the lake survey, and I was allowed till the 31st of May to gain strength and prepare to turn over my duties to my successor, who had been named when the order of February 7 was made.

On April 30 I submitted a report on the subject of reservoirs on the headwaters of the Mississippi (see House Ex. Doc. No. 285, Forty-first Congress, second session), and on May 24 a report on the Duluth and and Bois Fort reservation road (see Senate Ex. Doc. No. 104, Forty-first Congress, second session). On turning over my works, on May 31, I made a report on the condition of them, and suggested plans for continuing operations. (See Annual Report of the Chief of Engineers for

1870, pp. 226 and 227, for what relates to the Wisconsin River; pp. 224 to 289 relate to my Western works, and pp. 444 to 454 to Eastern works.)

My new station was fixed at Newport, R. I., and I was authorized to take with me such notes, drawings, &c., as were needed to complete my final reports. Everything, however, was left with my successor this season for reference, and directions were given to make copies of all needed for continuing improvements, assistants being employed under my direction for this purpose. There had been very little work doing at my new station prior to my arrival, and it promised to afford me an opportunity for uninterrupted employment on the unfinished reports, which related to the Minnesota River, the Wisconsin River, to the Upper Mississippi River, and to the bridges on the Mississippi River.

Congress, however, made provision for a number of improvements and surveys in my new district, and as this was my first experience in harbor-works on large bodies of water, my time was much taken up in studies of the subject as well as in carrying out the improvements. I also had to report on the proposals for the superstructure of Rock Island bridge, and was engaged a large part of the autumn on the Board of Engineers on the Ohio River bridges (see Annual Report of Chief of Engineers for 1871, pp. 397 to 457), and the international bridge across the Niagara River (see Annual Report of Chief of Engineers for 1871, pp. 217 to 221), which, with my duties at Newport and some minor operations, allowed no time for other work.

Progress in 1871.—The completion of the reports on the bridges on the Ohio River and the Niagara River, and other work, engaged me till March, at which time I had the Wisconsin and other unfinished Western river work sent to me. A thorough revision of all the maps and sections was made in this year, and complete tracings made of them and sent to the Chief of Engineers. Some parts of the map, on a scale of 2 inches to the mile, have been published with Colonel Houston's reports.

The improvement of the Wisconsin by means of wing-dams was begun this season, under Col. D. C. Houston, United States Engineers, and he visited me in June, and I gave him my views on the subject. He states in his annual report that he could not commence work earlier than June for want of necessary maps in my possession; but this was not my fault. All the maps he needed for commencing had been copied the summer previous, and left with the officer in charge of the work. In some way they were mislaid, and, as soon as I was informed of it, other copies were made. Colonel Houston reported the result of this year's operations with wing-dams as very satisfactory.

Besides my duties at Newport this year (see Annual Report of Chief of Engineers for 1871, pp. 727 to 828, inclusive), I was a member of a Board of Engineers to report upon the alterations in the Cincinnati bridge, and of another on the harbor of Chicago.

Progress in 1872.—My attention having been called to the success of the improvement of the Garonne River, in France, by a brief account of it in a report by Major Merrill, United States Engineers, on the harbor of Saint Louis, made to the mayor of that city in 1869, I obtained copies of the reports of M. Baumgarten and M. Fargue, published in the "Annales des Ponts et Chaussées," for the purpose of making an estimate of the cost and probable result of applying a similar plan to the Wisconsin River. M. Baumgarten's work we translated, reducing the measures to English ones, and copied the maps and diagrams, which it seems to me very desirable to have published. This work would convey a great deal of useful information, and correct some important misconceptions of river-

improvements. The work will be again referred to when treating of the improvement of the Wisconsin River.

This year, besides my duties at my station, which were very extensive (see Annual Report of Chief of Engineers for 1872, pp. 815 to 955, inclusive), I made a report on the subject of bridging the Mississippi at La Crosse (Annual Report of Chief of Engineers for 1873, pp. 554 to 563), and one upon the bridge across the Missouri at Saint Joseph, and its auxiliary works. I was, besides, a member of a board of Engineers on the Mississippi River, between the mouth of the Illinois River and Meramec River (Annual Report for 1872, pp. 358 to 366), and was engaged about one month in Washington as a witness in a suit brought against the United States by the contractors for the masonry of the Rock Island bridge.

Some considerable work, however, was done in preparing the material for the Wisconsin River report, but there was not enough time to write it out connectedly.

Progress in 1873.—Very considerable progress was made in the Wisconsin report in January and February, but a stop was made on the passage of the act for rivers and harbors on March 3, as it was necessary that the work at this station should be at once resumed (see Annual Report for 1873, pp. 947 to 1051). The remainder of this year was taken up with these duties and with service as member of the Board of Engineers on bridging the navigable channels between Lakes Huron and Erie (see Annual Report of Chief of Engineers for 1874, pp. 587 to 636); as member of the Board of Engineers on the bridge at Saint Louis (see Annual Report of Chief of Engineers for 1874, pp. 636 to 680); and of the Board of Engineers on the Fort Saint Philip Canal project (see Annual Report of Chief of Engineers for 1874, pp. 823 to 854). The duties on these boards occupied me almost exclusively six months.

Progress in 1874.—Early in this year I prepared, with great care, a report on the previous season's operations near Edgartown, Mass. On the 30th of June I was relieved of about half my duties at my Newport station; and the closing up of the different works, so as to make a proper transfer, consumed a good deal of time. For the duties at Newport, see Annual Report of Chief of Engineers for 1874, pp. 183 to 289, vol. 2. In the summer I was made a member of the commission on the reclamation of the overflowed lands of the Lower Mississippi. I, however, got on my former Western river operations, and completed the final report on the Minnesota River (see House Ex. Doc. No. 76, Forty-third Congress, second session, republished in Annual Report of Chief of Engineers for 1875, pp. 380 to 451). I also nearly finished the Wisconsin report, and probably would have finished it if I had not had to attend, early in December, the meetings of the commission on overflowed lands at Washington. This duty was not finished till near the middle of January (see report printed as House Ex. Doc. No. 127, Forty-third Congress, second session, reprinted in Annual Report of Chief of Engineers for 1875, pp. 536 to 678).

During 1874 I had an opportunity for the first time to study the large publication in relation to the construction of the great Ganges Canal in India, written by Colonel Cautley, of the royal engineers.

During the present year (1875) I have spent all the spare time I could get in working up the data on the Upper Mississippi River survey, some of which was applicable to questions arising in the present report, and also in revising and partly rewriting this report. It has been a long and in many respects a tiresome task, which is now completed. The frequent interruptions and long intervals at which it was suspended caused each

time a strong mental effort to recover what had passed out of the mind under the pressure of intervening occupation. Much of the interest belonging to the subject was thus wasted or lost. I have had the faithful assistance of a number of engineers, among whom I would especially name Messrs. D. W. Wellman, W. W. Rich, and J. P. Cotton.

The expense of the examinations and surveys in 1866, 1867, 1868, 1869, together with the construction and copying of the original maps and the preparation of this report and the diagrams to illustrate it, has been about $39,000. This is exclusive of my own labor and that of Major Suter.

CHAPTER II.

EARLIEST HISTORICAL ACCOUNTS OF THE ROUTE OF THE FOX AND WISCONSIN RIVERS.

INTRODUCTORY REMARKS—HISTORY OF DISCOVERY, &C., BY JOHN G. SHEA—Events leading to discovery—Adventures of the Sieur Nicolet, A. D. 1639—Discovery delayed by Indian wars—Discoveries by Father Marquette and the Sieur Jolliet—Captivity of and discoveries by Father Hennepin, 1680-'81—His rescue by Lieutenant Du Luth—EARLY HISTORY OF MICHIGAN, BY C. LANMAN—Condition of the country at the time of English occupation in 1760—Condition not changed by the English occupation, which nominally ended in 1783—Wonderful changes wrought by the American Republic—NOTE BY JONATHAN CARVER, 1766—RECOMMENDATION OF LIEUT. Z. M. PIKE, UNITED STATES ARMY, 1805—REPORT OF MAJOR LONG, UNITED STATES ARMY, 1817 AND 1819—MAP OF THE ROUTE, BY CAPT. H. WHITING, FIFTH UNITED STATES INFANTRY, 1819, WITH NOTES—CONCLUSION OF CHAPTER.

INTRODUCTORY REMARKS.

A very interesting natural feature is presented by the courses of the Wisconsin and Fox Rivers. They flow toward each other to within 1½ miles of meeting, and then, turning in opposite directions (although separated only by a low plain, across which their floods intermingle), the waters of the one pursue a southerly course to the distant Gulf of Mexico, and those of the other a northerly direction to the equally remote ocean-receptacle, the Gulf of Saint Lawrence. Each of these termini was a region beyond the bounds of the knowledge of the aboriginals on the banks of the two rivers. While all relating to the distant seas to which these waters flowed was to them a mystery, they could yet readily appreciate the advantages the near approach of the two streams afforded them as an easy route of communication between the Mississippi and the great lakes, and it was but natural that their wonder should ascribe the existing conditions to the work of a deity, and that they should make offerings to him for his favor, acts which appeared shockingly idolatrous to the early missionaries. Every enterprise of man in new regions seeks the paths which nature has provided, and thus in due course of events this route became the path by which white men first reached the great river—the Michi-Sipi—in early periods of American history.

HISTORY OF DISCOVERY, ETC., BY JOHN G. SHEA.

I take the following account of discovery from the work of John G. Shea, entitled "Discovery and Explorations of the Mississippi Valley," published by Redfield, Nos. 110 and 112 Nassau street, New York, 1853. This publication contains a print of the original map made by Father Marquette (then recently found among the records preserved at Saint Mary's College, Montreal), a reduced copy of which accompanies this

chapter. (Plate I.) The account which I present is mainly made up of quotations, with merely such minor changes and interpolations as large omissions and a little different arrangement require; the distinction between modified and quoted matter is intended to be preserved by quotation-marks.

Events leading to discovery.—"Quebec was founded by Champlain in 1608. He was soon joined by Recollet friars, and while he entered the Seneca country with his Huron allies, the intrepid Father Le Caron had ascended the Ottawa and reached the banks of Lake Huron. Subsequently, others joined him there; they invited the Jesuits to aid them, and the tribes in the peninsula were visited from Detroit to Niagara and from Lake Nipissing to Montreal.

"The capture of Canada by the English in 1629 defeated any further missionary efforts for a time, but it was restored in 1632, and the Jesuits set out to continue the mission alone. They now became the first discoverers of the greater part of the interior of this continent. * * * Within ten years of their second arrival they had completed the examination of the country from Lake Superior to the Gulf, and founded several villages of Christian neophytes on the borders of the upper lakes. While the intercourse of the Dutch was yet confined to the Indians in the vicinity of Fort Orange, and five years before Eliot, of New England, had addressed a single word to the Indians within six miles of Boston Harbor, the French missionaries planted the Cross at Sault Ste. Marie, whence they looked down on the Sioux country and the Valley of the Mississippi."

* * * * * * * *

Adventures of the Sieur Nicolet, A. D. 1639.—"As early as 1639 the adventurous and noble-hearted Sieur Nicolet, the interpreter of the colony, had struck west of the Hurons, and, reaching the last limits of the Algonquins, found himself among the Ouinepegon (Winnebagoes). * * * With these Nicolet entered into friendly relations, and, exploring Green Bay, ascended Fox River to its portage, and embarked on a river flowing west."

And he avers that had he sailed three days more he would have found the sea. The "sea" was the interpretation this traveler, like others, had given to the Indian name "Mississippi," which in their language signified "great water."

Discovery delayed by Indian wars.—The war which broke out in 1641 between the Iroquois (Six Nations) and the Hurons (Wyandots) destroyed the Jesuit missions to the latter, in the extreme west, and drove the Hurons from their lands. A remnant of them located themselves near the place known now as La Pointe, near Bayfield, on Lake Supérior, at which a mission called La Pointe du St. Esprit was located in 1658, but soon after abandoned for Macinac on account of the hostility of the Dakotas. Lake Superior receives its name from being the "Lac Supérieur," or Upper Lake, of the Ottawas. These Indian wars so retarded explorations in these regions that no material advance was made till 1673. But—

"The course of the Mississippi, its great features, the nature of the country, were all known to the western missionaries and the traders, who alone with them carried on the discovery of the West. Among the latter was Jolliet, who in his rambles also penetrated near the Mississippi."

As these Indian wars seemed an obstacle to so hazardous an undertaking on the part of the missionaries as the exploration of the great river, they—

"Urged the French court to set on foot an expedition, * * * and at last, on the 4th of June, 1672, the French minister wrote to Talon, then intendant of Canada, 'as, after the increase of the colony, there is nothing more important for the colony than the discovery of a passage to the South Sea, His majesty wishes you to give it your attention.'"

Discoveries by Father Marquette and the Sieur Jolliet.—Just at this time Frontenac succeeded Talon, who returned to France. The Sieur Jolliet was appointed to the charge of the expedition, and the pious Jesuit Père Marquette, was selected to accompany him. It is from the journal

and map of the latter that our best knowledge of the expedition is derived. Those made during the voyage by Jolliet were lost by him in descending the rapids of the Saint Lawrence River, near Montreal, and those subsequently made by him were from memory.

Marquette says:

"It was on the 17th of May, 1673, that we started from the mission of Saint Ignatius, at Michilimakinac, where I then was. Our joy at being chosen for this expedition roused our courage and sweetened the labor of rowing from morning till night. As we were going to seek unknown countries, we took all possible precautions that, if our enterprise was hazardous, it shoud not be foolhardy; for this reason we gathered all possible information from Indians who had frequented those parts, and even from their acc unts traced a map of all the new country, marking down the rivers on which we were to sail, the names of the nations and places through which we were to pass, the course of the great river, and what direction we should take when we got to it.

"Above all, I put our voyage under the protection of the Blessed Virgin Immaculate, promising her that if she did us the grace to discover the great river, I would give it the name of Conception."

Marquette was faithful to his promise, and inscribed on his map of the great river, "R. de la Conception." The Algonquin name, however, by which it had become known to the French through the Indians, has prevailed over that given by Marquette, and over that of "Rio del Espiritu Santo," given by the Spaniards to its lower course more than one hundred and fifty years previous, and over that of "R. de Colbert," the name of the great minister of Lous XIV, which Father Hennepin vainly endeavored to fasten upon it a few years after.

The name Michi-Sipi, literally great water, for a while thought to refer to the Pacific Ocean, has become the name of the great river for all time.

At the period of the expedition of Jolliet and Marquette the discoveries of the Spaniards on the lower Mississippi had been forgotten.

"And although explored for at least a thousand miles, known to have at least two branches equal in size to the finest rivers of Spain, to be nearly a league wide and perfectly navigable, it is laid down on maps as an insignificant stream, often not even distinguished by its name—Espiritu Santo—and then we are left to conjecture what petty line was intended for the great river of the West."

Let us resume the journal of Marquette. He says:

"We made our paddles play merrily over a part of Lake Huron and that of the Illinois" (Lake Michigan) "into the Bay of the Fetid" (Green Bay).

Here he remarks the tide at its head, an effect much studied since,

"Which has its regular flow and ebb, almost like that of the sea."

At this point, on the site of the present city of Green Bay, was the mission of Saint Francis Xavier.

The expedition reached Maskoutens on the 7th of June, which place was supposed by Marquette to be the limit of the previous discoveries of the French. This was probably the vicinity of the present village of Roslin, as Marquette says it was three leagues from the Wisconsin. According to the narrative of Major Long's expedition to the source of the Saint Peter's River in 1823, the league of Marquette and Hennepin is 2¾ English miles.

On "the 10th of June," Marquette says:

"Two Miamis, whom they" (the Indians) "had given us as guides, embarked with us in the sight of a great crowd, who could not wonder enough to see seven Frenchmen alone, in two canoes, dare to undertake so strange and hazardous an expedition.

"We knew that there was, three leagues from Maskoutens, a river emptying into the Mississippi; we knew, too, that the point of the compass we were to hold to reach it was the west-southwest; but the way is so cut up by marshes and little lakes that it is easy to go astray, especially as the river leading to it is so covered with wild oats

that you can hardly discover the channel. Hence we had good need of our two guides, who led us safely to a portage of twenty-seven hundred paces, and helped us to transport our canoes to enter this river, after which they returned, leaving us alone in an unknown country, in the hands of Providence."

* * * * * * *

"The river on which we embarked is called Meskousing" (Wisconsin); "it is very broad, with a sandy bottom, forming many shallows, which render navigation very difficult. It is full of vine-clad islets. On the banks appear fertile lands diversified with wood, prairie, and hill. Here you find oaks, walnut, whitewood, and another kind of tree with branches armed with long thorns. We saw no small game or fish, but deer and moose in considerable numbers.

"Our route was southwest, and after sailing * * * 40 leagues on this same route, we reached the mouth of our river, and * * * safely entered the Mississippi on the 17th of June, with a joy that I cannot express."

I shall not follow Father Marquette further on in the journal of his voyage in detail, as he says no more about the Wisconsin River, and never visited it again. He continued down the Mississippi to about the mouth of the Arkansas River, where he and Jolliet no longer doubted that the Mississippi terminated in the Gulf of Mexico. The object of the expedition as ordered by the French court was thus accomplished, and to proceed farther would endanger the results of their explorations by exposing them to the liability of being captured by the Spaniards on the Lower Mississippi. They, therefore, turned back and ascended the Mississippi to the mouth of the Illinois River, up which stream they proceeded as far as the portage near the present site of Chicago, where they crossed over to the shore of Lake Michigan, and coursed along it to the mission at Michilimackinac.

Captivity of and discoveries by Father Hennepin, 1680–'81.—In 1680–'81 Father Hennepin, a Franciscan, a member of one of the religious orders which succeeded the overthrow of the Jesuits, descended the Illinois River to its mouth, and was there made prisoner by the Dakotas. They carried him up the Mississippi above the Falls of Saint Anthony, which he named after Saint Anthony of Padua, and then up the river he named Saint Francis (since known as Rum River, from it dark amber-colored water), to its source in Lake Issati (now named Mille Lacs), where he spent the winter. The Dakota traditions still make this lake the ancient center of their nation.

His rescue by Lieutenant Du Luth.—At Lake Issati Father Hennepin was ransomed by a French officer named Du Luth, and returned with him by way of the Wisconsin and Fox River route to the French settlements. This closes what I have taken from the works of Mr. Shea.

Early history of Michigan, by C. Lanman.—A very good account of the early occupation of Wisconsin is given by Mr. Charles Lanman in his History of Michigan, published by E. B. Smith & Co., Detroit, from which I take a few general remarks.

Condition of the country at the time of English occupation in 1760.—Except the noble aims of the missionaries, the only object of the French was to pursue the fur-trade, which was vigorously carried on through every channel which nature presented. Such small settlements as they formed about the trading-posts were prevented from expanding by tyrannical restrictions. Agriculture, instead of being stimulated, was repressed and the settlers were but the servants of gigantic corporations, royal monopolies, whose rule was solely for their own pecuniary benefit.

The Frenchmen affiliated with the savages, married their women, and their progeny of half-breeds became the main working force of the fur-companies. Their villages were small and confined to limited areas, and they developed a condition of life which here and there still survives through all the mutations of succeeding events, which have swept away

the red man, given rise to populous cities of another race, and reticulated the land with railways.

Condition not changed by the English occupation, which nominally ended in 1783.—The victory of the English over the French at Quebec in 1760, which caused in the same year the capitulation at Montreal and the surrender to the English of the control of the whole region, effected little change there. The fur-trade was pursued as before. The Frenchmen and their descendants remained unmolested.

Wonderful changes wrought by the American Republic.—Even the success of the American Revolution, by which the control of a large piece of the fur-bearing regions passed in 1783 to the control of the United States, made but little change in the development of the country till the steady approach of the pioneer American settlers caused the gradual extinction of the Indian titles to the land, and the creation of territorial governments, which soon after developed into States. It is almost wholly within the last fifty years that the marvelous transformation of our Northwest has been brought about, which contrasts so pleasantly with what existed before.

NOTE BY JONATHAN CARVER, 1766.

The village at Prairie du Chien, when visited by Jonathan Carver in 1766, was estimated by him to contain three hundred families. A remnant of this village, as distinct as the aboriginals from the inhabitants of the American city, still occupies the old village site.

RECOMMENDATIONS OF LIEUT. Z. M. PIKE, UNITED STATES ARMY, 1805.

In 1805 Lieutenant Pike, United States Army, in a report of an exploration toward the source of the Mississippi, recommended the building of a fort on the high bluff on the Mississippi opposite the mouth of the Wisconsin River, to control the movements of the Indians along it and protect the white settlers.

REPORT OF MAJOR LONG, UNITED STATES ARMY, 1817 AND 1819.

The Wisconsin River was visited by Maj. S. H. Long, United States Topographical Engineers, in 1817, and again in 1823, and he thus describes it:

"The Wisconsin River, from its magnitude and importance, deserves a high rank among the tributaries of the Mississippi. When swollen by a freshet, it affords an easy navigation for boats of considerable burden through a distance of more than 180 miles. Its current is rapid, and, like the Mississippi, it embosoms innumerable islands. In a low stage of water its navigation is obstructed by numerous shoals and sand-banks. At the distance from its mouth above mentioned" (too great an estimate by 60 miles) "there is a portage of one mile and a half, across a flat meadow, which is occasionally subject to inundation, to a branch of Fox River of Green Bay, thus affording another navigable communication which boats have been known to pass. The valley of the Wisconsin is somewhat narrower than those of most other rivers of this region, but in other respects is very similar to them. The high country here assumes a more hilly and broken aspect, and the soil becomes more sandy and meager." (See Long's Expedition to the Source of the Saint Peter's River, vol. 2, chapter v.)

MAP OF THE ROUTE BY CAPT. H. WHITING, FIFTH UNITED STATES INFANTRY, 1819, WITH NOTES.

In 1819 the Fifth Regiment of United States Infantry made the voyage from Fort Howard, near Green Bay, to Prairie du Chien, via the

Fox and Wisconsin Rivers, and Capt. Henry Whiting, of that regiment, prepared a map of the route on a scale of an inch to 4 miles, with numerous marginal notes. From these the following description is compiled:

Fort Howard is on the left bank of the Lower Fox River, about 2 miles from its mouth; about 3 miles above are rapids and a mill, and between these and the fort was a French settlement, occupying both banks of the river, and numbering about sixty families. From the rapids at the mills to the Grand Chute the current is generally so rapid as to render a tow-line and setting-poles necessary, and the boats are for the most part moved up in that way. In this space were passed, first, the Little Kakalin Rapids, one-quarter of a mile in length, easily surmounted with setting-poles and oars; second, the Great Kakalin Rapids, 1 mile in length, very broken and violent, where the boats are unloaded, and the baggage transported 1,000 yards by land; third, La Petite Chute, a ledge stretching across the river, making a descent of about 12 inches; fourth, La Grosse Roche, which makes a perpendicular fall of about 2 feet. Both these two last mentioned are surmounted with loaded boats.

At La Grande Chute there is a perpendicular fall of about 4 feet all across the river, and the boats have to unload and the baggage is transported 500 yards. Above the Grande Chute and below Lake Winnebago there are two or three inconsiderable rapids which are surmounted without much difficulty or delay.

The Fox River thence to the portage has always a strong current and is often entirely overgrown with grass and wild rice, but presents no other impediments. It winds through a narrow prairie bordered by oak-openings and undulating lands, generally of a beautiful appearance, but probably not remarkably rich in their soil, which, wherever the river washes them, seems to be a sandy, reddish loam.

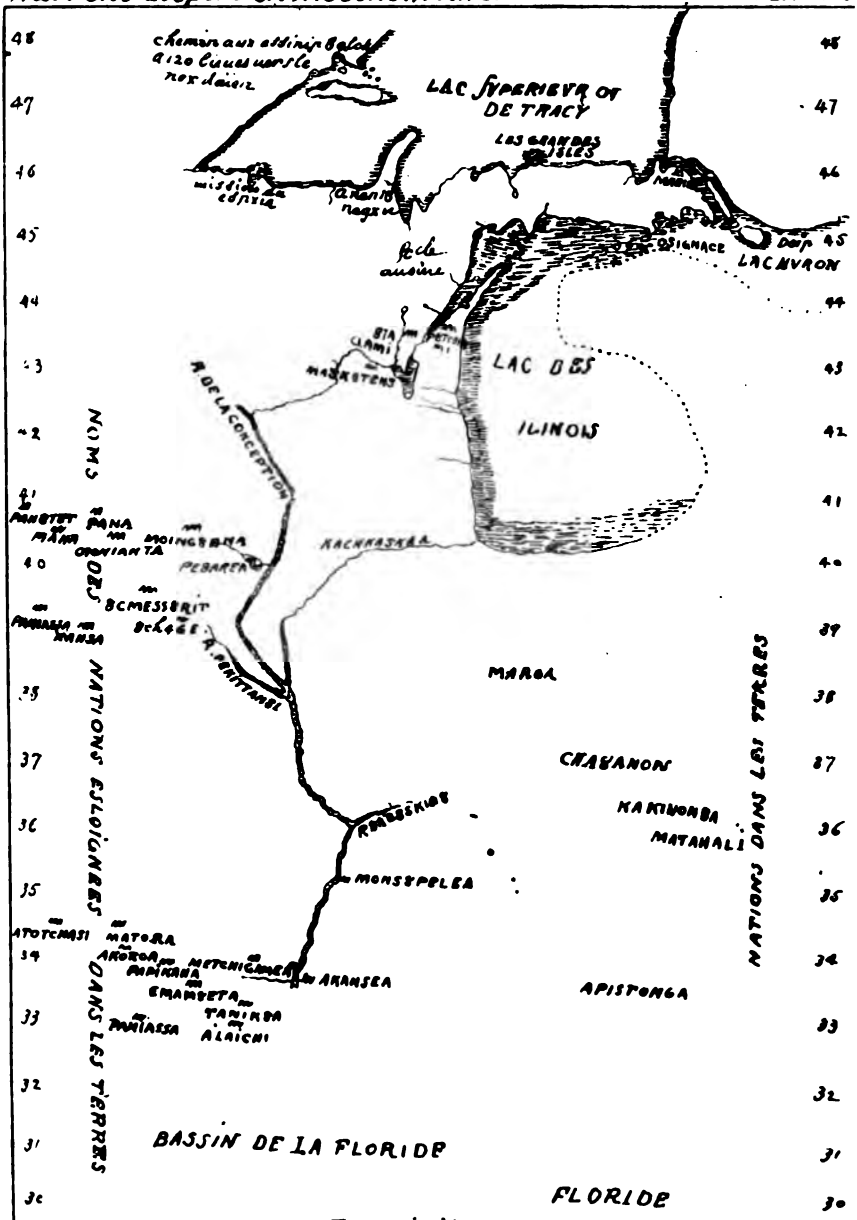
The portage between the Fox and Wisconsin Rivers is about 2,500 yards; the road runs over a marshy prairie. There is a Frenchman residing on the rising ground between the rivers. He keeps the proper transportation for boats and baggage.

The limestone bluffs and highlands begin on the Winconsin about 8 miles below the portage. Just above Prairie du Sac appears to be the apex of the highland of the Wisconsin and the head of the great valley through which that river winds. The river is full of islands, formed by the sand-bars, which are constantly increasing in number. The general depth of the river is, at the ordinary height of the water, 4 to 5 feet, but the sand-bars often extend entirely across the river, and have not more than 8 or 10 inches of water; the sands, however, are quick, and oppose but little resistance.

From a peak of the highlands near the river (Bogus Bluffs), about 500 feet high, one has a view of the valley and the highlands of the Wisconsin. The valley is 4 and 5 miles wide, about half covered with wood, and apparently rich. The highlands appear to be nearly parallel, and eroded ridges, cut transversely, presenting their broken sections to the valley, and all of them exhibiting more or less marked strata of rocks, which wear the aspect of castles, towers, turrets, &c., dilapidated and desolate. These highlands appear to be the common level of the country broken into ridges, and covered with a scanty vegetation.

CONCLUSION OF CHAPTER.

The history of the Wisconsin and Fox River route and the region it traverses continues to relate principally to Indian traders, military



Fac-simile
of the Autograph map of the
Mississippi
or
Conception River
drawn by
Father Marquette
at the time of his voage
From the original preserved in St. Mary's College
Montreal

operations, and Indian wars, down to the close of the Black Hawk war, about 1832. It was along the Wisconsin that this heroic chief and his despoiled followers attempted to escape, and near the mouth of which they were all destroyed, except a few that were granted quarter.

Wisconsin formed part of the Northwest Territory till the year 1848, when it was admitted as a State in the Union. Much prosperity attended the first settlements along the Wisconsin River on account of the natural advantages for business which it presented. The construction of the railroads from Milwaukee to La Crosse and from Madison to Prairie du Chien soon drew the trade and inhabitants away from the banks of the river. The warehouses and many dwellings were abandoned and fell into decay. Long reaches of river became the almost undisturbed homes of wild animals. The Indians, who had been moved farther west began to struggle back to their old haunts. While we were examining the rivers, the smoke of their camp-fires could frequently be seen, and around them they cooked and ate their game in primitive simplicity. Their canoes were often met by us. Almost every feature of the landscape as it was two hundred years ago seemed in places restored, and it required no effort of the imagination, in the haze and mists of twilight, to picture to ourselves the canoes of Jolliet and Marquette as they glided down the stream on their adventurous voyage of discovery.

CHAPTER III.

HISTORY OF THE IMPROVEMENT OF THE ROUTE ALONG THE FOX AND WISCONSIN RIVERS SINCE SURVEYS AND IMPROVEMENTS WERE BEGUN; PROGRESS OF THE IMPROVEMENTS AND CONDITION DOWN TO 1870.

Survey under War Department, in 1836, by Mr. Center, civil engineer—Survey under War Department, in 1837, by Mr. Pettival, civil engineer—Bill for the improvement of these rivers and for a canal to unite them, reported by United States Senate committee in 1839—Survey of the Fox and Wisconsin Rivers, under War Department, by Captain Cram, in 1839—Report upon survey and estimates of Captain Cram, made by committee of House of Representatives in 1846—Survey of Green Bay. under War Department, by Capt. W. G. Williams, in 1845—Lands granted to the State, on its admission into the Union, for improving the navigation of the Wisconsin and Fox Rivers and for constructing a canal to unite them; act approved August 6, 1846—Operations in 1848; report of board of public works for 1848—List of rapids on Lower Fox River, with the fall at each—Operations in 1849; report of board of public works for 1849—Character of the Wisconsin and difficulty of improving its channel, stated by Alton—Operations in 1850; report of board of public works for 1850—Operations in 1851; report of board of public works for 1851—Plan of improving the Wisconsin River, by Acting Commissioner Croswell—Operations in 1852; report of board of public works for 1852—Condition of the Wisconsin River improvement and a plan for continuing the same, by Acting Commissioner Richardson—Table of expenditures on the Wisconsin River—Expenditures made in 1852—Table of total expenditures to date—Geological Survey of the Wisconsin—Progress of improvement in 1853—Surrender of the works of improvement, lands, &c., by the State to a company, June 1, 1853—Company chartered, with conditions, July 6, 1853—Condition and character of the works in 1854, by C. D. Westbrook, jr.—Reservoir on the headwaters of the Wisconsin as a means to increase its low-water depth, suggested by Mr. Westbrook—Expenditures by the company from August 20, 1853, to November 15, 1854—PROGRESS OF THE FOX AND WISCONSIN RIVER IMPROVEMENT SUBSEQUENT TO 1855-'56—Additional lands granted to the State by Congress—Increased capacity of the improvement required by the State—Condition of the works January, 1859; report of the chief engineer of the company, Mr. D. C. Jenné—Condition of the improvement in 1860; report of the president of the company to a committee of the State legislature—Navigation of the Wisconsin can be improved by running a steamboat; money expended otherwise would be of no avail; from same report of president of company—Expenditures from October 3, 1856, to December 31, 1859—Expenditures from beginning of improvement in 1848 to

1859—Operations in 1860-'61-'62; report of superintendent of company—Increased capacity necessary for passage of gunboats; estimated cost of, by Mr. Jenné, civil engineer, in 1862—RENEWAL OF INTEREST IN THE IMPROVEMENT BY THE UNITED STATES—Report of Committee on Naval Affairs, Thirty-seventh Congress, upon the improvement, with estimates for an increase of capacity so as to pass gunboats, 1863—Company having failed to perform its agreement, the works of improvement, land, &c., were sold in 1866—Green Bay and Mississippi Canal Company, incorporated by the State August 15, 1866—Examination and estimates ordered by Congress—Condition of these rivers, improvement, &c., 1866—Condition of the Lower Fox River improvements in 1866—Condition of the Upper Fox River and improvement in 1876—Condition of the Wisconsin River in 1866—WORKS OF IMPROVEMENT, &C., IN 1867—WORKS OF IMPROVEMENT IN 1868—WORKS OF IMPROVEMENT IN 1869—CONCLUDING REMARKS TO CHAPTER III.

Survey under War Department in 1836, *by Mr. Center, C. E.*—On account of the increasing importance of the Fox and Wisconsin route of communication, a survey was made under the instructions of Colonel Abert, chief of Topographical Engineers, United States Army, in 1836, at the entrance of the Fox River into Green Bay. This survey was made by Mr. A. J. Center and Lieutenant Rose, both of the Army, the former of whom made the report after he had resigned from the Army. Mr. Center's report was dated in April, 1838, and I believe it was not published. The survey extended from Fort Howard to Tail Point, a distance of about 6 miles. The map was made on a scale of 8 inches to a mile.

Great interest was taken in the improvement of this route by the War Department, as it would facilitate the movement and supply of troops operating to protect settlers against hostile Indians.

Survey under War Department in 1837 *by Mr. Pettival, C. E.*—In April, 1837, instructions were issued from the Topographical Engineer Bureau of the War Department to J. B. Pettival, civil engineer, to make a survey and examination of the Fox River, for the purpose of determining the best practical mode of improving the navigation. A part of the Upper Fox was meandered while so overflowed that the chain was buoyed up by floats and stretched on the surface of the water. This survey was so hurried that another one was recommended. The report was printed as Doc. No. 102, House of Representatives, War Department, Twenty-fifth Congress, third session. Mr. Pettival's description of, and remarks upon, the physical features of the route are very interesting, and will be referred to by me in treating of the physical features.

Bill for the improvement of these rivers and for a canal to unite them, &c.—On February 11, 1839, the United States Senate Committee on Roads and Canals, to which were referred the memorials of the legislature of the Territory of Wisconsin (Wisconsin being all that was left of the Northwest Territory after Michigan was admitted in 1837) upon the subject of improvement of the navigation of certain rivers in Wisconsin, reported a bill the first section of which provided "for the improvement of the navigation of the Wisconsin and Neenah (Upper Fox) Rivers, and for their connection by a canal." The report says:

> The Wisconsin may be rendered navigable by the removal of the timber from its banks where it overhangs the channel, and occasionally contracting its waters by closing the heads of the sluices or shallow channels around the islands. * * * Its general width is about a mile; these improvements, therefore, will permit the steamboats which navigate the Upper Mississippi to ascend this river to the Great Bend nearest to Lake Michigan.

A grant of land was recommended to supply funds for this improvement.

I have quoted in full the method recommended for improving the navigation of the Wisconsin River. It has ever since been regarded with

particular favor, and, although it may be made to accomplish as much as was then proposed, it is a work of great difficulty, if it is not impracticable, to make it meet the present wants of a through line of water-transportation between the lakes and the Upper Mississippi. I shall especially quote all the plans proposed for improving the Wisconsin River as we reach them in the following chronological history of the improvements.

Survey of the Fox River, under the War Department, by Captain Cram, in 1839.—The next surveys for the purpose of improvement on the Fox and Wisconsin route were conducted by and under Capt. T. J. Cram, Topographical Engineers, in 1839. This report is dated January, 1840, and forms Senate Document No. 318, Twenty-sixth Congress, first session. Its title is "Report on the further survey and estimate of the cost of improving navigation of the Fox and Wisconsin Rivers, and connecting the same by a navigable canal or water-communication."

Report upon survey and estimates of Captain Cram, made by the committee of House of Representatives in 1845.—This report of Captain Cram is also embodied in the report of the House Committee on the Public Lands, House of Representatives, No. 551, Twenty-ninth Congress, first session, dated April 6, 1846, which is the one I have consulted. There are printed with this report both general and special maps. He refers in the opening of his report to three routes for communication by water between the Mississippi and Lake Michigan, as follows:

Route No. 1. Through the valley of the Wisconsin River to the portage; thence by a canal across the portage into the Fox; thence down this river to Green Bay.

Route No. 2. Through the valley of the Rock River, from its mouth to the head of its natural navigation; thence by canal into the southern extremity of Lake Winnebago; thence through this lake and the lower part of the Fox River into Green Bay.

Route No. 3. Through the valley of the Illinois River, from its mouth to the head of its navigation; thence by means of a canal along the valley of the unnavigable part of the river to the southwestern part of Lake Michigan.

The general features of route No. 1 and the more immediate surveys called for are stated as follows by Captain Cram:

Those steamers that are in the habit of navigating the Upper Mississippi, in attempting to ascend the Wisconsin in times of low water, meet with sand-bars. These are the only obstructions, and they are of a nature such as to be continually shifting their positions. The same steamers, however, which are unable to ascend in lowest stages of water, meet with no difficulty in ascending the Wisconsin during spring and fall as far up as the portage; and there is no doubt that steamers of sufficient tonnage could be constructed with a draught sufficiently small to allow of their passage up the Wisconsin in the present condition of its sand-bars, even in times of ordinary low water; and as the most serious obstacles pertaining to the whole of route No. 1 were known to be in the Fox, it was deemed best to commence the survey upon the part of the Wisconsin in the vicinity of Fort Winnebago and proceed across the portage into the Fox and down the same to Green Bay. In pursuance of this plan, not only has a general reconnaissance of the whole Fox been made, but all places demanding improvement have been surveyed in a manner necessary to estimate the cost of improving the navigation, as required in the act of Congress which directed the survey and estimate to be made.

Captain Cram, therefore, made surveys at the portage between the Wisconsin and Fox Rivers; at the Winnebago Rapids at the outlet of Lake Winnebago, and at Grande Chute, Little Chute, Grand Kakalin, Rapide Croche, Little Kakalin, and Depère (the parts occupied by rapids) in the Lower Fox. His proposed plans of improvement contemplated canals 40 feet width at bottom, 55 feet at water-line, and 5 feet depth. The lock-chambers were to be 110 feet by 30 feet. Dams were to be built at the rapids; and sharp elbows, bar-deposits, and trees were to be removed from the Upper Fox. The estimate of total cost was $448,470.18, divided up as follows:

1. At Depère, dam and lock	$20,306 79
2. At Little Kakalin, dam and lock	28,978 84
3. At Rapide Croche, dam and lock	19,062 29
4. At Grand Kakalin, dam and locks	107,574 85
5. At Little Chute, dam and locks	99,693 60
6. At Grande Chute, dam and locks	82,382 74
7. At Winnebago Rapids, dam and lock	23,748 50
8. The portage between Fox and Wisconsin Rivers, canal and locks	64,085 81
9. For removing elbows, bar-deposits, trees, &c., along the Upper Fox	6,230 50
10. For superintendence, 6 per cent	25,385 18
Total	448,470 18

Captain Cram made a comparison of the estimated cost of improving the Lower Fox River with the estimated cost of an independent canal leaving Lake Winnebago at Clifton and striking the Lower Fox below Rapide Croche. The cost of this latter plan was estimated at three times the other. Captain Cram's report gives a map of this route on a scale of $\frac{4}{5}$ inch to a mile.

The committee reported a bill to grant—

The alternate sections for only 2 miles on each side of the route, which is estimated to be sufficient for the completion of the work.

It will be seen from the above that Captain Cram made no surveys of the Wisconsin River, nor any estimate for its improvement. That the natural navigation was greatly overvalued is shown by the little use made of it after the route along the Fox River was subsequently opened, which latter failed mainly of its utility from the inadequacy of the Wisconsin River for navigation. Indeed, this navigation was so little valued that no serious opposition was raised to the bridging of the river by the Milwaukee and Prairie du Chien Railroad in such a way as to completely prevent it being used by steamboats in low stages.

Survey of Green Bay under War Department, by Capt. W. G. Williams, in 1845.—In 1845 a survey of Green Bay was made by Capt. W. G. Williams, Topographical Engineers, U. S. A., the map of which was published as H. Ex. Doc. (War Department) No. 170, Twenty-ninth Congress, first session, on a scale of 2 miles to 1 inch.

Lands granted to the State on its admission to the Union, &c.—The report of the House committee last referred to, made April 6, 1846, recommending a grant of lands, was in accordance with the report of the Senate Committee on Public Lands on the same subject, dated January 8, 1844. An act accordingly was passed, and approved August 8, 1846, which is as follows:

Be it enacted by the Senate and House, &c., That there be, and hereby is, granted to the State of Wisconsin, on the admission of such State into the Union, for the purpose of improving the navigation of the Fox and Wisconsin Rivers, in the Territory of Wisconsin, and of constructing a canal to unite the said rivers at or near Portage, a quantity of land equal to one-half of three sections in width on each side of the said Fox River, and the lakes through which it passes, from its mouth to the point where the Portage Canal shall enter the same, and on each side of said canal, from one stream to the other, reserving the alternate sections to the United States, to be selected under the direction of the governor of the State, and such selection to be approved by the President of the United States. The said river, when improved, and the said canal, when finished, shall be, and forever remain, a public highway for the use of the government, free from any toll or other charge whatever for the transportation of the mails, or for any property of the United States, or persons in their service passing upon or along the same: *Provided*, That said alternate sections reserved to the United States shall not be sold at a less rate than $2.50 the acre: *Provided also*, That no pre-emption claim to the land so reserved shall give the occupant, or any other person claiming through or under him, a right to sell lands at any price less than the price fixed in this act, at the time of the settlement on said lands.

SEC. 2. *And be it further enacted*, That as soon as the Territory of Wisconsin shall be admitted as a State into the Union, all the lands granted her shall be and become the

property of said State, for the purpose contemplated in this act, and no other: *Provided*, That the legislature of said State shall agree to accept said grant upon the terms specified in this act, and shall have the power to fix the price at which said lands shall be sold, not less than one dollar and twenty-five cents the acre, and to adopt such kind and plan of improvement on said route as the said legislature shall from time to time determine for the best interest of the State: *Provided also*, That the lands hereby granted shall not be conveyed or disposed of by said State, except as said improvement shall progress. That is, the said State may sell so much of said lands as shall produce the sum of twenty thousand dollars, and then the sales shall cease until the governor of said State shall certify to the President of the United States that one-half of said sum has been expended upon said improvements, when the said State may sell and dispose of a quantity of said lands sufficient to reimburse the amount expended, and the fact of such expenditure shall be certified in the manner herein mentioned.

SEC. 3. *And be it further enacted*, That the said improvement shall be commenced within three years after the said State shall be admitted into the Union, and completed within twenty years, or the United States shall be entitled to receive the amount for which any of said lands may have been sold by the said State, provided that the title of purchase under the sales made by the State in pursuance of this act shall be valid.

The State of Wisconsin accepted the above grant with its provisions by act of its legislature, approved June 29, 1848. Another act, approved August 8, 1848, containing 47 sections, provided for the conduct of the improvement, from which the following is extracted:

Section 1 provides that the construction of the improvements contemplated by the act of Congress, * * * and the superintendence and repair thereof after completion, shall be under the direction and control of a "board of public works."

Section 5 provides that—

The said commissioners shall first commence the construction of the canal, and after said canal is finished, the improvement of the Wisconsin and Fox Rivers shall be commenced, beginning at both ends of the canal down each stream, so as to make said streams navigable as the improvements progress, with the exception of the improvement of the several rapids on Fox River below Lake Winnebago, which may be commenced at any time said commissioners may think proper. After the construction of the canal the net proceeds of one-sixth of the sales of the grant of land is hereby set apart for the improvement of the Wisconsin River, and five-sixths of said proceeds to the improvement of the Fox River: *Provided*, That no more than ten thousand dollars shall be expended in improving the navigation of the Fox River from the said canal to Lake Winnebago, until further action of the legislature of the State, or until the said river shall be made navigable to Green Bay.

* * * * * * *

SEC. 15. In the construction of such improvements the said board shall have power to enter on, take possession of, and use all lands, waters, and materials, the appropriation of which for the use of such works of improvement shall, in their judgment, be necessary.

SEC. 16. When any lands, waters, or materials, appropriated by the board for the use of said improvement, shall belong to the State, such lands, waters, or materials, and so much of the adjoining lands as may be valuable for hydraulic or commercial purposes, shall be absolutely reserved to the State, and whenever a water-power shall be created by reason of any dam erected or other improvements made on any of said rivers, such water-power shall belong to the State, subject to future legislation.

Sections 17, 18, 19, 20, and 21 make provisions for compensating parties from whom any property is taken under authority specified in section 15.

SEC. 22. As soon as any portion of said improvements shall be completed, so as to admit of use, the board shall make rules and regulations from time to time in respect to the passage of boats, rafts, and other floats through the canal and locks, and all matters connected with the navigation thereof, and impose such forfeitures for the breach of any such regulations as may be deemed reasonable by them.

The foregoing extracts from this act of the Wisconsin legislature contain all there is in it affecting considerations of engineering and navigation. There is nothing in the act fixing upon the dimensions of the canal and locks.

Operations in 1848—*Report of board of public works for* 1848.—The first board of public works appointed by the legislature of Wisconsin consisted of James B. Estes, Albert S. Story, John A. Bingham, Curtis Reed, and H. L. Dousman. They appointed C. R. Alton the chief engineer. The annual report of operations in 1848 was dated January 19, 1849. Their operations consisted in making surveys and plans of improvement on the Fox River and of the canal at "Portage," and the expenditures were $1,631.81. In the plan of improvement they adopted they decreased the depth proposed by Captain Cram from 5 feet to 4 feet at low water, and enlarged the dimensions of the locks from 110 feet by 30 feet to 125 feet by 30 feet.

Captain Cram, in his measurements of the fall on the rapids of the Lower Fox necessary to be overcome by dams and locks, was considerably under the mark, and he does not enumerate among the list of rapids the Cedar Rapid just above Little Chute, or else includes them both in one. For convenience of reference in the report of operations following, I will give now a correct list of the several rapids, with their distance apart and the fall at each, as it was ascertained at the time of the examination made by Major Suter, in 1866. It is as well to note here that the map published with our report gives two locations of Rapide Croche; the upper one is the location of the dam, the other is a mistake.

List of rapids on Lower Fox River, with amount of fall and distances apart between head of each.

Name.	Fall.	Distance apart.
	Feet.	*Miles.*
Depère	8	0
Little Kaukana (or Kakalin)	8	6
Rapide Croche	8	0
Grand Kaukana	50	4¼
Little Chute	38	2¼
Cedar Rapid	10	0¾
Grand Chute	38	4
Winnebago Rapid	10	4½
Green Bay to Lake Winnebago	170	23

During our reconnaissances of the route in 1866 we were permitted by the canal company to make tracings of the diagrams of all the improvements up to that date. These were filed in the engineer headquarters at Washington, with the report, dated January 21, 1867, and can there be referred to.

Operations in 1849—*Report of board of public works for* 1849.—The second annual report of the board of public works is dated January 21, 1850. Contracts were made for guard and lift locks and the two sections of canal at Portage; for improving both channels at Winnebago Rapids; for improving both sides of the river at Grand Chute; for improving the east side of the river at Rapide Croche; and for improvement of west side of river at Depère. The improvements at Depère were contracted for at the nominal sum of $1. Those at Winnebago Rapids and the Grand Chute were not begun this year. Fair progress was made at the other points. A steam-dredge was also built, at a cost of $12,000, and set to work removing bars in the Big Bend at and below Mechan Creek, and cutting a new outlet to the lake (Lake Puckaway).

Character of the Wisconsin and difficulty of improving its channel, &c.—An examination of the Wisconsin River below Portage was made in 1849 by the chief engineer, Mr. Alton. (His full report is given in the assembly journal for 1850, p. 571.) The following from this report is interesting, and shows views held in regard to the Wisconsin River which ruled at this period in the progress of the improvements. At the time of the examination, the river being at an "extremely low stage, a channel having not less than 2½ feet could be traced the entire distance from 'Portage' to the mouth." He further says:

The general character of the stream is such that it would be extremely difficult, if not impossible, to make any improvement in the channel by the ordinary method. The current is uniformly strong, running at the rate of 3 or 4 miles an hour, frequently divided into several channels or sloughs interspersed with numerous sand-bars, and, to one entirely unacquainted with it, it would seem to present insuperable obstacles to navigation.

Mr. Alton thought the overhanging trees the greatest obstacle in the way of light-draught boats, and recommended that they should be cut away and a few snags removed. He also thought the steam dredge boat should be set to work to cut an entire new channel from about half a mile below "the lower ferry" (probably Bridgeport) to the Mississippi, following a line of sloughs or pond-holes, as exhibited on a map accompanying the report, and that one of the present channels of the Wisconsin should be closed up. He estimated the entire cost of this at $6,000.

The total expenditures in 1849 were as follows:

Depère, valve-gear	$411 86
Rapide Croche	6,949 62
Upper Fox, steam-dredge, $12,000; operating, $1,463.80	13,463 80
Portage, canal and locks	13,447 19
Wisconsin River (probably for examining)	333 52
Engineers	6,120 97
Printing	544 85
Contingent	3,972 82
	45,244 63

Operations in 1850—*Report of board of public works for* 1850.—The third annual report of the board of public works of the operations during 1850, dated January 1, 1851, gives the following information:

The lock at Depère was completed and opened for the passage of boats early in the summer, but the miter-sill was found to be 2 feet too high, and must be lowered that much. Some rocks were removed from the channel between Depère and Rapide Croche.

At Rapide Croche the lock and section of canal were completed at an expense considerably greater than the first estimate. The lock had to be sunk a foot lower and the section of canal made 1,000 feet longer. A serious breach in the dam at this place occurred in April.

At the rapids of Grand Kaukana and Little Chute arrangements for doing the work, though nearly consummated, failed.

At Cedar Rapids the dam was completed and considerable portion of the lock-pit excavated.

At the Grand Chute the work progressed rapidly, till want of funds compelled a suspension.

At Winnebago Rapids the dam was completed and about two-thirds of the canal excavated.

The Upper Fox River was remarkably low. The dredge was employed deepening the channel at the outlet of Lake Puckaway and between this lake and Buffalo Lake; also in cutting a new channel at the entrance into Buffalo Lake, and in cutting off a large bend near the junction of the Neenah so as to shorten distance and avoid Mud Lake.

On the Wisconsin River some portion of the overhanging trees that interfered with the navigable channel was cut down and removed last winter. A crane-scow for the removal of snags and to afford facilities for the cutting and removal of such trees as may still interfere with the navigation was constructed in the autumn.

The following-named expenditures were made in 1850:

At Depère for freight		$10 00
For removing rocks between Depère and Rapide Croche		338 16
At Rapide Croche to contractors		13,222 43
At Cedar Rapids to contractors		7,549 32
At Grand Chute to contractors		4,656 59
In dredging on Upper Fox and repairs to dredge-boat		4,728 97
On Portage, canal and locks		21,031 58
On Wisconsin River, pay of men and supplies, chopping wood	$1,180 17	
On Wisconsin River, for surveying	26 00	
On Wisconsin River, for scow and machinery	799 00	
		2,005 17
For stationery, printing, pay of commissioners, engineers, &c		5,506 49
		59,048 71

The commissioners, at the close of their report, say:

There is a deficiency of about 170,000 acres in the grant of land for the improvement.

Operations of 1851—*Report of board of public works for* 1851.—The fourth annual report of the board of public works of the work done in 1851, dated January 2, 1852, gives the following information: The operations in 1851 were carried on under a new board, consisting of Caleb Croswell, David M. Lay, and Timothy Burns. Mr. Croswell had the supervision of the operations of the dredge-boat; Mr. Alton, the former chief engineer, resigned, and Mr. J. Kip Anderson, who had been assistant engineer, was appointed in his place. Mr. J. E. Day was appointed consulting engineer, "a gentleman," says the report of the board, "whose labors for the past six years on the Youghiogheny and Monongahela Rivers made the selection appropriate and acceptable." In all the new contracts made this year the original plan of the locks was so changed as to make those to be built hereafter 160 by 35, with 5 feet depth on the miter-sills. The contract for the work at the Grand Kaukana and Little Chute provided for payment being made in scrip.

At Depère, the lowering of the old lock 2 feet was completed in May.

At Rapide Croche, the old dam was of brush, and a breach occurred n it in the spring of 1850. It was entirely unsuited to the location. It was decided to replace it with a spar-dam. The work was commenced and was well under way; the crib-work having been carried across the river, the abutment on the east side finished, and a number of spars in their places. The probable expense of repairs at this point is estimated at $7,494.45.

At Great Kaukana Rapids—

A large portion of the canal was excavated, the protection-wall on the upper section more than one-half finished, and the upper lock-pit ready to receive the walls of the lock. From the lock-pits the earth was removed, and the excavation of the rock was to be carried on during the winter.

At the Little Chute—

But little has been done beyond grubbing and clearing of the line and the delivery of materials.

At the Cedar Rapids—

The dam and section of the canal, as well as the excavation of the lock-pit, are completed, the only work remaining to be performed being the building of the lock, for which the timber, plank, and iron have been prepared and the stone excavated.

The plan "having been changed" from a timber to a composite lock of the enlarged size, "the cost of the work will much exceed the original estimate." Work delayed for want of funds.

At the Grand Chute the contractors were embarrassed in their work by the difficulty of negotiating the warrants with which they were paid. Yet, "the improvement has progressed rapidly." "The timber and other materials for the dam and locks are delivered." At the Winnebago Rapids, since the last report, very little additional work has been done.

On the Upper Fox River—

During the past season the dredge has been in active operation on this stream, havd ing performed much more service than in any previous year. The earth excavater amounted to 145,440 cubic yards; boat at work, 170 days; average 855 cubic yards pe- day; maximum work during long days was 1,768 cubic yards per day.

The Portage Canal and locks were finished and accepted. A breach, however, occurred on the 28th of September.

During the prevalence of a flood, never before equaled in extent at that season of the year, the portage between the Fox and Wisconsin Rivers became so overflowed that the water from the last-mentioned stream broke through the canal-bank a short distance from the guard-lock, washing away at that point from 12 to 15 rods of the embankment.

A breach of about the same extent occurred near the other end of the canal. There was a third breach, of limited extent compared with the others. The report says:

The entire cost of these repairs, so elaborately descanted upon in particular quarters soon after the disaster, does not exceed the sum of $700; and a permanent barrier is now in course of construction to provide against such an occurrence in the future.

This report contains the regulations and rates of toll adopted for the route, and these were kept in force by the law transferring the works to a company in 1853.

Plan of improving the Wisconsin by Acting Commissioner Croswell.—The following plan of improving the navigation of the Wisconsin River below Portage is proposed in the report of Mr. Croswell, acting commissioner for improving the Wisconsin River, this year:

I trust I may be allowed respectfully to allude to the present navigable condition of the Wisconsin River below Portage. On that point, much neglected as it has been, but little has hitherto been said, and much less accomplished, by way of improvement. The opinion has been indulged, and, in my humble judgment, too readily so, that very little, if anything, can be done to aid the navigation of that stream between Fort Winnebago and the Mississippi. According to a former report, the principal obstacles to its improvement were found at the different points on the river where the stream is widest. At such places the depth of water is necessarily less than in the narrower portions, where the current is more rapid. From such observations as my position in the board for the past two years has enabled me to make, and from the experience of those most familiar with the obstructions of the stream, the opinion has been forced upon me that if the whole volume of water at the head of these flats was turned to one of the shores, all the main difficulties in the way of the successful navigation of the Wisconsin would at once be overcome. This, in my humble apprehension, could be easily effected by driving piles from the opposite shore as far into the stream as it might be deemed best to obstruct it, and by sinking a pier at the termination to prevent the current from washing away the work. Against these piles trees should be placed in such manner as to cause the sand to bank and form a dam. This dam would naturally turn the water to the narrow channel, and increase the velocity of the water to such an extent as to create a channel through the flat, and yet not be sufficiently strong to prove of any hinderance to steamboat navigation. At proper points, where these dams might occur, a convenient crossing could be established; and were wing-dams of this description to be thrown out at convenient intervals between Fort Winnebago and the Mississippi River, there would seem to my mind no apparent obstacle in the way of the largest steam-vessels passing with ease up and down the stream during the entire season of navigation.

This annual report also contained the report of an examination of the Wisconsin River from Portage up to Beaulieux Rapids, made by William

L. Dewitt, civil engineer, during 1851. He submitted an estimate of $52,264.36 for improving this portion of the river.

The following expenditures were made in 1851:

Depère	$928 95
Rapide Croche	1,284 63
Grand Kaukana	915 83
Grand Kaukana and Little Chute, scrip issued*	26,000 00
Cedar Rapids	8,888 93
Grand Chute	4,819 85
Upper Fox, dredging, &c	6,300 77
Portage Canal	12,047 96
Survey of Wisconsin above Portage	1,275 54
Contingent fund, pay of commissioners, &c	6,828 66
	69,290 52

Operations in 1852—*Report of board of public works for* 1852.—The fifth annual report of the board of public works of the work done in 1852, dated January 1, 1853, is signed by Peter H. Prame, William Richardson, and Andrew Proudfit. The pamphlet contains the reports of the chief engineer, of Mr. Richardson, acting commissioner for the improvement of the Wisconsin River, and Mr. Prame, the commissioner in charge of the dredge-boat. The purpose of the improvement is considered in this report, and its condition and future prospects discussed.

At Depère work was continued on the building of the lock, and rocks removed from the channel between it and Rapide Croche.

At Rapide Croche, a portion of the west dam having been carried away, an unsuccessful attempt, costing $2,732.28, was made to repair it. It was finally replaced by a spar-dam, bolted to the rock bottom.

At Little Kaukana Rapids it was found that a dam and lock were necessary, and a plan was prepared for making them, the estimated expense being $17,922.92.

At the Grand Kaukana the work was nearly completed. At Little Chute the work was carried on vigorously.

At Cedar Rapids the work was nearly completed.

At Grand Chute the work was carried on vigorously.

On the Upper Fox River dredging was continued.

At the Portage Canal the right to use the water-power at the lift-lock was leased for a term of thirty years, at $275 per year.

Condition of the Wisconsin River improvement, &c.—I copy here the report of Acting Commissioner William Richardson, dated January 1, 1853, as it gives an authentic and complete account of all that had been done up to this time on this part of the improvement:

I deem it my duty to make, at this time, a brief statement of the plan, progress, &c., of the works of improvement on the Wisconsin River, which I have had the honor to direct as acting commissioner on said river. The act of our State legislature of the 8th of August, 1848, set apart one-sixth of the net proceeds of the lands granted by Congress to aid in the improvement of the Fox and Wisconsin Rivers, and to connect the same by a canal (after the construction of the canal) for the improvement of the Wisconsin River, which act I conceive to be yet in force. The acts of April 14 and 19, 1852, provide for the same thing, and make it obligatory on the board of public works to commence the improvement of said river the present season, and to complete the same, as soon as practicable, upon the plans submitted by the chief engineer in his report for the year 1849, or in some other manner as best calculated to open a channel through the several flats on said river. The law making it thus obligatory on the board to commence this work the present season, I took the earliest opportunity (after my appointment upon that part of the improvement) to examine the stream, and determine, if possible, a practicable mode of improvement. I made an excursion on the

* NOTE.—In the consolidated table given farther on, being unable to proportion this from the reports, I divided it equally between the two.

G. K. W.

river, from the Portage Canal to its mouth, for the purpose of ascertaining the cause of the deposits of sand in particular localities, believing a thorough knowledge of this cause necessary to a successful improvement of said river. By repeated observations upon the stream in a low stage of water, I became satisfied that the plan submitted in the engineer's report above referred to was the proper plan, and that brush, earth, gravel, and stone were the proper materials to be used in the construction of the dams.

I am pleased to have it in my power to state, in this connection, that at least one of your honorable body, Chief Engineer Mr. J. Kip Anderson, and Assistant Engineer Mr. S. G. Callaghan (after accompanying me in a small row-boat from the Portage to the mouth of the stream) fully concurred with me in opinion upon this subject. The lack of funds applicable to this work I deem a sufficient apology for not commencing earlier in the season. I had the work commenced within two days after the first advertisement of lands, from the sales of which we were entitled to moneys to pay on said works. The character of the work is such that I deemed it impracticable to let the same by contract; consequently I selected good, efficient men as superintendents, and hired men by the day to do the work. I commenced at the Portage Canal and have proceeded down the river, as per act of the legislature of August 8, 1848. I have had seven dams erected, and two now in course of erection. The aggregate length in linear feet of the nine dams is 4,205, and constructed at a cost of about $11,000. In putting a dam across a branch of the river, where a connection could be made with an island, I have generally located the dam some distance from the head of the island, for the following reasons: first, the dam thus located is not subject to a raking effect of the current, as would be the case if the location was at the head of the island; second, a large recess is formed for the accumulation of sand above the dam, which will add great strength to it; lastly, the fall below the dam to the foot of the island being but little, the water below the dam, during a rise in the river, will keep very nearly upon a level with that above; consequently, when the water flows over the dam there will be no danger of an undermining process. I have had the dams given good width of base, and raised them but little above low-water mark, believing it unnecessary to obstruct the free flow of the water when high. The opinion indulged in by many, that wing-dams should angle down stream, I conceive to be erroneous. If the dam is not at right-angle with the stream, it should (in my opinion) angle up instead of down stream. If angling down, the current will rake it, and naturally tend to fill the channel below the dam with sand. But if angling up stream, both of these effects will undoubtedly be avoided. There has been expended under previous administrations of the board of public works, in surveys, chopping timber, &c., upon this river, the sum of $3,872.73. The contingent expenses properly chargeable to this part of the improvement, say $1,500, making the aggregate amount of expenditure or liability incurred for the improvement of this stream up to the time of finishing the two dams above mentioned, $16,372.73.

Several of the dams are under water, and, from a careful observation, I am satisfied that the current will produce no injurious effect upon them. If these dams produce the desired effect (which I have no doubt of), I think it is safe to assume that unobstructed navigation from the mouth of the river to Portage City, for steamers drawing 2 feet water, can be effected for a sum not exceeding $25,000, which, added to the present liabilities, will make the sum-total for this part of the improvement $41,372.73, which is certainly a less sum than the law sets apart for the same.

I have employed a small force in clearing overhanging timber from the channel. A statement of their progress, the expenditures on this part of the improvement in detail, the materials, implements, &c., applicable to operations next season, &c., I will present you at an early day after the completion of the two unfinished dams.

I am informed by Mr. H. Meriton, civil engineer, that he was employed on this work, and that four of the dams were located between the ferry-bridge, above Portage, and the mouth of the Baraboo River. Some remains of these are yet to be seen, as shown on the map of our survey made in 1867.

Two dams were located near the mouth of Honey Creek; one above on the right bank still standing, connecting an island with the main shore; the other, below the creek on the left bank, running out from the shore, in which logs were used, is still partly remaining, but it has become separated from the main shore by the wearing away of the bank, and now occupies a place well out in the stream, a fate which attends all wing-dams not constantly cared for.

There were no other dams erected on the Wisconsin before or since the year 1852, except by mill-owners or others to obtain water-power. I have a letter from Mr. B. J. Stevens, vice-president of the Canal Com-

pany, saying that the Improvement Company did not erect any works on the Wisconsin River for its improvement, since the works were transferred to them.

The other commissioners, in speaking of the work done this year (1852) on the Wisconsin River, say:

If this cheap kind of dam which we recommend to be constructed should be found not to answer the desired end, and as the cost of placing piles for the erection of more suitable wing-dams to confine the water to one channel would far exceed the means at the disposal of the State, we must fall back upon the suggestion of the engineer of 1849, and rely upon the removal of the overhanging trees, and the snags from the river, which can be done at the estimated cost of $5,000. We are inclined to the opinion that the frequent running of the boats up and down this, now, will keep the channel open and make it navigable, as is found to be the case on some portions of the Upper Mississippi and Missouri having a similar current and bottom.

Table of expenditures on the Wisconsin River.—In the foregoing statement Mr. Richardson says that the expenditures properly chargeable to the improvement of the Wisconsin River, up to this time, amounted to $16,372.73.

Of this he says the dams in 1852 cost about	$11,000 00
The report of the board for 1850 gives for scows and chopping	2,005 17
The survey below Portage, by Mr. Alton, in 1849, was	333 52
The survey above Portage by Mr. Dewitt, and report cost, as stated in report for 1851, $1,275.54, and for 1852, $491.16	1,766 80
Chargeable to contingent fund (says Mr. Richardson)	1,500 00
	16,605 49

Thus $16,605.49 is the largest sum we find in the official reports charged directly to the Wisconsin River. Mr. Richardson states the whole amount to be $16,372.73.

There was expended in 1852 on crib and dock work, for protection of the guard-lock, in the portion of the Wisconsin River contiguous to it, $5,905.47. This was paid for out of the Portage Canal fund, I believe, and charged to that in the commissioners' report. If added to the other expenses on the Wisconsin River improvement, which it seems hardly chargeable to, we should have the whole expenditure on that river $22,510.96, of which only $13,000 was actually spent in works of improvement, to wit: For scows and cutting overhanging trees in 1850, $2,005.17; for dams in 1852, $11,000. This is the only authority that I can find for the statements of Mr. Westbrook, in his report in 1854, that $25,000 had been expended in the improvement of the Wisconsin River.

There was a difference of opinion as to where the funds were to be obtained for improving the Wisconsin River, and in the expenditures stated in the report of the board for 1852 the $11,000, which Mr. Richardson says was expended on the Wisconsin, does not appear. I have accordingly, in putting it in the following table of expenditures, increased the amount they reported by that much.

Expenditures made in 1852.

Depère	$15 00
Rapide Croche	4,648 94
Great Kaukana / Little Chute } Divided equally in the consolidated table—G. K. W.	47,262 42
Cedar Rapids	9,559 17
Grand Chute	22,993 23
Upper Fox, dredging	2,433 15
Portage Canal	23,227 29
Wisconsin River, survey, $491.16; improvement, $11,000.	11,491 16
Contingencies, including patent for lock-gates, &c	15,513 19
	137,143 55

I have not seen the report of the board of public works in 1853, closing up their connection with the work, but in the report of Mr. C. D. Westbrook, jr., dated December 1, 1854, made to Isaac Seymour and William J. Averill, trustees of the mortgage-bonds of the Fox and Wisconsin Improvement Company, it is stated, p. 50, that the total expenditure by the State, up to the time the improvement was surrendered to the company, was $428,855.83.

From all the information I can obtain from the reports of the board of public works, the amounts expended on the works in 1848, '49, '50, '51, and '52, amounted to $312,359.22. There must, then, have been charges for other purposes, connected with the sale of the lands, interest on obligations to pay, &c., amounting at that time to the difference, viz, $116,496.61. I have entered it under the column of miscellaneous expenditures in the year 1853, in the following table, in which all the expenditures heretofore given are consolidated.

Expenditure in improvement of Fox and Wisconsin Rivers, under State management, up to 1853.

Name.	1848.	1849.	1850.	1851.	1852.	1853.	Total.
Depère	....	$411 86	$10 00	$928 95	$15 00	....	$1, 365 81
Little Kaukana	....	....	....	....	....	....	....
Rapide Croche	....	6, 949 62	13, 222 43	1, 284 03	4, 648 94	....	26, 105 02
Grand Kaukana	....	....	....	13, 915 83	24, 631 21	....	37, 547 04
Little Chute	....	....	....	13, 000 00	23, 631 21	....	36, 631 21
Cedar Rapids	....	....	7, 549 32	8, 888 93	9, 539 17	....	25, 997 42
Grand Chute	....	....	4, 656 50	[illegible], 819 88	22, 993 23	....	32, 469 67
Winnebago Rapids	....	....	....	....	....	....	....
Upper Fox River	....	13, 463 20	4, 728 97	6, 300 77	2, 433 15	....	26, 926 69
Portage Canal	....	13, 447 19	21, 031 58	12, 047 96	23, 227 29	....	69, 754 02
Wisconsin River	....	333 52	2, 005 17	1, 275 54	11, 491 16	....	15, 105 39
Miscellaneous	$1, 631 81	10, 638 64	5, 844 65	6, 828 66	15, 573 19	$116, 496 61	156, 953 56
Total	1, 631 81	45, 244 63	59, 048 71	69, 290 52	137, 143 55	116, 496 61	428, 855 83

Geological survey of the Wisconsin.—In the year 1852 the report of the geological survey of Wisconsin, &c., made, under direction of the United States Treasury, by David Dale Owen, United States geologist, was published by Lippincott, Grambo & Co., Philadelphia. In this, pp. 277 to 293, is the report of an examination made in 1847 of the Wisconsin River, from Portage up to its source, by Col. Charles Whittlesey, and, on pp. 510 to 520, the Wisconsin, from Portage to the mouth, made in 1849, by Dr. B. F. Shumard.

These reports contain valuable information in regard to these rivers, and attention is called to them here in the chronological order of their appearance.

Progress of improvement in the year 1853.—The effort to provide for the expenses of the works of improvement in previous years by the proceeds of the sale of public lands granted by the United States had only partially succeeded. At two places, Great Kaukana and Little Chute, the contractor had so far been paid entirely in scrip, and at other places payments had been only granted by certificates or warrants of indebtedness. The sale of lands had proceeded too slowly to meet current expenses when prosecuting the work in a proper manner, and an interest on the first cost was accruing, to add to the amount of final payment. A further grant of land was also required.

To meet the wants of the case, an issue of State bonds was proposed, but this being held unconstitutional by a majority of the legislature—

It resolved to surrender the whole improvement, the balance of the grant of public lands remaining unsold, hydraulic privileges, &c., to a company, upon receiving guarantees that the work should be accomplished, and the parties interested as contractors or otherwise secured from loss.

Surrender of the works of improvement, lands, &c.; company chartered, &c., &c.—An association styling itself the "Fox and Wisconsin Improvement Company," comprising Otto Tank, Morgan L. Martin, Urial H. Peak, James G. Lawton, Theodore Conkey, Mason C. Darling, Benjamin F. Moore, and Edgar Conklin, all of Wisconsin, concluded its articles of agreement on June 1, 1853. This association applied to the legislature for an act of incorporation, which was granted, and approved July 6, 1853.

The second, third, and seventh sections of the act required the parties comprising the association to give certain bonds, and file releases of contractors, which conditions were duly complied with, July 20, 1853, whereupon the work was surrendered, and taken possession of by the company.

Section 2 of this act—

* * Conditioned that the said company shall vigorously prosecute the said improvement to completion, and complete the same within three years from the passage of this act on the line located by the board of public works, and as contemplated in the report of the board of public works, and estimated by the chief engineer, on the 1st day of January, 1853, in a substantial and durable manner, and so as to enable boats of 2 feet draught, and a breadth of 30 feet, during ordinary stages of low water, to pass with facility from Green Bay into the Wisconsin River. * *

Section 2 also provided—

That the said improvement shall in all future time be free for the transportation of the troops of the United States and their munitions of war, without payment of any tolls whatever; and that no provision of this act shall be so construed as to allow, permit, or authorize the charge or collection of any tolls or transit duties for the passage of any vessel or merchandise, or property of any kind, along or over the main channel of said rivers.

And also that—

The said company shall charge no higher rate of tolls than was established by the board of public works for the years 1851–'52, which rates shall be uniform for each lock, and to all persons and boats passing through them.

Section 8 provides that—

The State may become the owner and proprietor of the works of improvement constructed under this act, and of the whole works of improvement, at any time after twenty years, upon paying to said association or their assigns the actual costs expended by said association in the construction of said improvement over and above the avails of the grant of land by Congress, and applied or received by said company to aid in said improvement, the said lands to be estimated at the rate of one dollar and twenty-five cents per acre.

For the purpose of completing the work, the company, in 1853, resolved to issue bonds to the amount of $500,000.

In 1853, the legislature of Wisconsin authorized the Milwaukee and Prairie du Chien Railway Company to build three bridges across the Wisconsin River, which authorization provided for draws of 50 feet width, and required that the stream where touched or intersected should be restored to its former usefulness.

The bridges built under this law were, however, located entirely with regard to convenience to the railroad alignment, and so little regard was paid to the stream that not only has navigation been almost cut off, but the very permanence of the bridge-piers has been maintained only by such an excessive use of riprap-stone as renders a proper restoration of the navigation almost impossible, without rebuilding the bridges themselves.

Condition and character of the works in 1854, *by C. D. Westbrook, jr.*—The very interesting report of Mr. Westbrook, frequently referred to by me before, gives the condition of the work at the date of November 15, 1854, from which the following is taken:

At Depère the work is considered as finished. At Little Kaukana, materials for dam and lock have been collected.

At Rapide Croche the work is considered finished.

At Grand Kaukana the work is generally finished, with the exception of swinging the gates and graveling the dam.

At the Little Chute there yet remains 22,500 cubic yards of excavation, the raising of the walls of the upper of the two combined locks, the swinging of the gates, and the graveling of the dam.

At Cedar Rapids the work is generally finished, with the exception of swinging the gates and graveling the dam. At the Grand Chute the walls of one of the locks are yet to be raised; 15,000 cubic yards of excavation and embankment remain; the gates for the locks are to be swung and the dams to be graveled. Winnebago Rapids: At the Neenah, or southern channel of exit from Lake Winnebago, the canal lock and dams have been completed, ready for use when the dam below at the Grand Chute is tightened. A wall will probably be extended from the lower and outer wing of the lock, to deflect the current, which now sets across its entrance into the channel. The improvement here was executed without cost to the State, in consideration of the use of the water-power. The lock and canal, however, are of the original size. The former is 60 feet wide on the bottom and 4 feet deep, and the latter 140 feet in length by 35 feet width in the chamber.

At Menasha, where the second and northern channel issues from the lake, the dam is erected and the canal excavated. The lock-pit was excavated and the foundation in progress at the commencement of November. The contract time for completion extends to the 1st of July. Here, as at Neenah, the contract for the execution of the work without cost to the State was taken in consideration of the use of the water-power thereby created. Subsequently it was determined to enlarge the canal to a bottom width of 100 feet and a depth of 5 feet, and the locks to a size in the chamber of 160 feet by 40 feet. This change, by contract, involved an expenditure of $16,734.40 beyond the original plan. The expenditure yet to be made at this point is $10,916.87.

On the Upper Fox River the dredge had continued working on the river, principally above the Forks. This dredge was 110 feet long, 28 feet wide, with draught of 30 inches. It has removed, on an average, 850 cubic yards a day for a season of 170 days, excavating at times 1,700 cubic yards a day. Up to the close of 1854 there had been expended on the Upper Fox (including $12,000 for the first cost of the dredge-boat) about $30,000. The present navigation is confined to one steamboat, which ascends daily to Berlin, a distance of about 40 miles; and horse-boats and scows, by means of which lumber is carried from the Wolf River, through the Upper Fox, into the Wisconsin, and down the latter stream to different markets on the Mississippi. A steamboat, however, has made weekly trips to Montello, 100 miles above Lake Winnebago, from Oshkosh, a city of 3,000 inhabitants, at the entrance of the Fox into Lake Winnebago.

Reservoir on the headwaters of the Wisconsin River, &c.—It does not appear that anything was done upon this river in 1853 and 1854. Mr. Westbrook thought a great improvement to the low-water navigation might be made by—

The location of a dam upon the upper waters of the Wisconsin, where the public lands have not as yet been brought into market, that will create a reservoir in which a quantity may be stored up from the high water in the spring of the year, to maintain an equable supply throughout the dry season, sufficient for the uninterrupted navigation of the stream.

Expenditures by the company from August 20, 1853, to November 15, 1854.

At Rapide Croche		$292 00
At Grand Kaukana		32,902 21
At Little Chute		50,950 73
At Cedar Rapids		7,546 17
At Grand Chute		42,218 17
At Winnebago Rapids (Menasha Channel)		5,817 53
On Upper Fox (dredge-boat)		3,833 16
On docks and barges built	$9,621 84	
On expenses, engineers, &c	8,132 09	
Interest	9,547 70	
		27,301 63
Total		170,861 60

The cost of completing the work, according to the terms of the act of the legislature surrendering the improvement to the company, is estimated, on November 28, 1854, by J. Kip Anderson, the engineer of the company, as follows:

At Grand Kaukana	$2,887 00
At Little Chute	7,673 68
At Cedar Rapids	901 85
At Grand Chute	10,031 65
Total	21,494 18

There were, however, many other improvements contemplated by the company, such as a dam and lock at Little Kaukana and one dam and lock, at least, on the Upper Fox River.

Appended to this report will be found the specifications of the manner of constructing the canal and locks and dams. Following them will be found the bills of timber, of stone, and of iron used in their construction. In the notes attached to the specifications will be found other items embraced therein, which will complete the description of the work.*

In regard to its general character, I would say that, while differing in opinion in regard to a few of its details, the plan of the work and its execution, so far as I have been able to judge, exhibit a full assurance of effecting the purpose for which it was designed and of security against the action of destructive forces.

The dams, with a single exception, are bolted to the bare rock. The one excepted is at the Grand Kaukalin. It rests upon crib-work filled with stones, and is to be further protected with the same material at one of its wings, at the foot of its spars, and at the break of its overflow, from the undermining action of the water.

The same security, in the character of the foundations, has been had in the construction of the locks. The walls of all at the Grand Kaukalin, two at the Little Chute, one at the Cedars, and three at the Grand Chute, rest upon a smooth surface of limestone, out of which material their walls have raised. One at the Grand Chute has its walls laid in timber and earth foundations. Though the work was executed a year since, not the least sign of their settlement can be perceived, which would readily have been exhibited by the starting of the plank in the flooring course.

Of the additional locks with timber foundations, one at Depère, one at the Rapide Croche, and one at Neenah, have been built and in use for several years. The first is of stone, faced with timber and plank, and the other two of timber filled with clay. The remaining locks with timber foundations are two combined at the Little Chute.

Another fact of great importance in regard to the stability of the work is its exemption from the danger of freshets, inasmuch as no tributary of any size empties into the Lower Fox. Lake Winnebago is an immense reservoir, controlling the rise of the water below, whose fluctuations are never more than between 3 and 4 feet.

Whenever the banks of the canal, which are generally upon the bottom-lands of the river above high-water mark, come in contact with the current, they are protected from its action by heavy walls.

These facts, together with an examination of the specifications, will remove all apprehensions in regard to the stability of the work.

* I have made these specifications an appendix to my report and used them as the basis of my estimate of the cost of locks for a canal along the Wisconsin River.
G. K. W.

PROGRESS OF THE FOX AND WISCONSIN RIVER IMPROVEMENT SUBSEQUENT TO 1855-'56.

I have no information of the details of the improvement for this period, and I can give only general features.

Additional lands granted to the State by Congress.—In the session of 1854-'55 acts of Congress were passed by which the State was authorized to select, in addition to the previous grant, two sections per mile for every mile of improvement, &c. The total grant would then amount to five sections per mile for the whole length of the Fox River and lakes through which it runs, a distance of about 216 miles.

Increased capacity of the improvement required by the State.—In 1856 the legislature of Wisconsin passed another act, requiring an increased capacity to the improvement, so that boats drawing 4 feet water could navigate the Lower Fox, and those having a draught of 3½ feet could use the Upper Fox; the locks to be 160 feet long by 35 feet wide, admitting of the passage of boats 144 feet long by 34 feet wide, of a tonnage of from 300 to 350 tons. This work was commenced immediately and prosecuted with energy until the revulsion in the money market in the fall of 1857, when it was in part suspended. (See Report No. 55, H. Rep., Thirty-seventh Congress, third session, dated March 3, 1863.) I have not positive authority for it, but presume that the increased capacity required by the legislature was in consideration of the additional land grant made by Congress, which was given to the company on the condition that it should execute its deed of trust, covering all the unsold lands granted by Congress, the works of improvement, &c., to three trustees, who should sell the same in case the company did not perform its part.

As to the expenditures between the years 1854 and August 25, 1856, Mr. John F. Seymour. in his report to the special committee of the legislature, in 1860, states that "the amount expended by the company for construction and navigation to August 25, 1856, is reported at $504,806.06." As Mr. Westbrook's report gave the amount expended up to the close of the year 1854 as $170,861.60, we have $333,944.46 as the expenditure for the intervening period. I can only infer what this was expended for by the following extracts from the report of Mr. Jenné, chief engineer, &c., giving the condition of the work in 1856.*

Condition of the works January, 1859; *report of the chief engineer, &c.*—The report of Mr. Daniel C. Jenné, chief engineer, &c., dated January 7, 1859, made to the governor, says that in June, 1856, the navigation from Green Bay to Lake Winnebago was opened, but, owing to the dam and lock not being built at Little Kaukana, it was suspended in the latter part of the season.

That in 1857 the navigation of the Lower Fox was good until September, and from that time to the middle of October, the time the dam at Little Kaukana was completed, there was some difficulty between this point and Rapide Croche, which ceased thereafter.

That during 1858 there was no interruption of navigation, except for a few days, about the 1st of May, when a break occurred in the canal at Menasha. Steamboats have made their regular trips daily from Green Bay to Oshkosh and Fond du Lac. They have also run regularly from Oshkosh to Berlin, and for a considerable portion of the year from Berlin to Montello and Packwaukee, and occasionally to Fort Winnebago. Navigation was opened on the 12th of April and closed on the 27th of

* In the spring of 1857 the Milwaukee and Prairie du Chien Railroad, crossing the Wisconsin River three times, was opened through to the Mississippi River.

November, making seven and a half months, which is nearly one month more than the average of New York canals.

The report of Mr. Jenné informs us also—

That, since the passage of the act of 1856, the company have been actively at work at different points on the Fox River.

Taking the works in the order adopted by me, we learn from Mr. Jenné's report the following in regard to the condition of the works at the close of the year 1858:

At Depère the lock is not yet commenced, but will probably be built the coming year.

At Little Kaukana the dam, lock, and canal section are completed.

At Rapide Croche the lock and section of canal is about four-fifths completed, and will be brought into use by the 1st of June, 1859. At Menasha (Winnebago Rapids) the section of canal is completed.

On the Upper Fox the lock and dam at Moutello is over one-half finished, and will be completed by October, 1859. The lock at Fort Winnebago has been completed. The lock at Portage City has not been commenced, but will probably be built during the coming year. The canal at Portage City is not finished, but will progress during the year 1859, and is now in a condition to pass boats up to the city. A large amount of dredging has been done, and by the opening of navigation in the spring there will be no trouble in passing steamboats from Green Bay to Portage City, and barges will be able to pass out into the Wisconsin River.

The company have two powerful dredge-boats, which will be engaged in deepening the upper river at all points which may be necessary during the next year. Two wing-dams have been built in the vicinity of Princeton on the bars, which contract the water and form a good channel over the bars. Several more wing-dams will be built the coming year between Princeton and Berlin, and these, with the dredging which will be done, will form a good channel for boats drawing 3½ feet of water at all places on the Upper Fox during ordinary low water on said river.

On the Wisconsin River no work had been done for improving it since the passage of the act of 1856. Mr. Jenné examined the river from Portage City to the mouth in October, 1857, and says: "I am satisified that it can be successfully navigated, and that within the next two years steamboats will run direct from Green Bay to the Mississippi River, and thence up and down that river to any points where boats now run."

Condition of the improvement in 1860.—The next report of improvement obtained by me is the printed one of Mr. John F. Seymour, president of the company, made to a select committee of the Wisconsin legislature in 1860.

Mr. Seymour states that he was appointed president of the company in 1858. He states:

At Depère the lock, by a change of plan, sanctioned by the governor in 1857, is to be lengthened, but can be used with some repairs for another year or two. At Rapide Croche the new cut-stone lock for canal, constructed by Messrs. Conkey and Wesley, will be ready for use this spring. The work on the Lower Fox is completed so as to give 4½ feet depth of water in all ordinary seasons; and during the extraordinary drought of last summer, a small amount expended in tightening the dams relieved the navigation from all difficulty, except the Menasha Channel. The company is now at work on this channel, and no further

serious difficulty is apprehended there, unless there should be a recurrence of a similar drought.

On the Upper Fox River, by a change of plan, approved by the governor in February, 1857, the lock and dam in the vicinity of Princeton have been dispensed with, and the bars improved by means of wing-dams, piers, and dredging, and a large amount of this kind of work has been done between Berlin and Mechan River. It is proposed to put in several other wing-dams, both above and below Berlin, against the recurrence of a season similar to that of last summer.

A dam and lock have been partially built at Montello. A new lock has been built at Fort Winnebago, on the site of the one built by the State, and sunk 5 feet lower than the old lock, to give sufficient depth for navigation. It is now anticipated that a lock and dam of low lift may have to be built about four miles below Fort Winnebago in consequence of the trouble experienced in keeping that part of the river open for navigation. The lock into the Wisconsin River at Portage was repaired last year, and with some additional repairs will answer all the purposes of navigation the present year. It is intended that both dredges shall be employed for the most part of the ensuing season on the Upper Fox. In regard to the navigation of this river, W. J. Clemans made affidavit on the 14th of March, 1860—

Then he had charge of the dredge-boat No. 2, owned and worked by the Fox and Wisconsin Improvement Company in the year 1859; that, in the month of August last, he came on said dredge from Menasha to Portage; that, where he found the depth less than 3½ feet, he dredged it to the depth of 5 feet, except on the Omro bar, where he dredged 4 feet deep; that he did not find it necessary to dredge from Berlin to within 4 miles of Portage; that of this 4 miles two had a depth of 5 feet water; that he did not dredge the remaining 2 miles, having been ordered to the upper lock to dredge it out, which he did; that these two miles aforesaid had been dredged out by said company, but had filled up with sand during that season; that said Upper Fox is constantly filling up with sand, and will require dredging every year; that the water in Fox River was lower last year than it had been known to be for seven years past.

Navigation of the Wisconsin to be improved by running a steamboat, &c.—Mr. Seymour says, with reference to the Wisconsin, the company have been—

Guided in many respects by the opinions of men of experience, such as Hercules, Dousman, and other gentlemen familiar with that stream; that the navigation of the river by steamboat would make a channel as in the Mississippi, and that generally money expended otherwise would be of no avail, although there may be some points where the stream will have to be contracted by wing-dams, &c. A steamboat made regular trips from Portage to Sauk in the latter part of last season, and several other boats ran out of the Fox into the Wisconsin during the season.

Expenditures from October 3, 1856, *to December* 31, 1859.—The following table shows the expenditures for all kinds of work from October 3, 1856, the time the work passed into the hands of the company, up to December 31, 1859:

Statement of expenditures by Daniel C. Jenné, chief engineer and superintendent, for work done on the Fox and Wisconsin improvement from October 3, 1856, *to December* 31, 1859.

Kind of work.	1856.	1857.	1858.	1859.	Total.
Lock, dam, and section at Little Kaukana	....	$34,404 96	$10,063 56	$901 50	$45,370 12
Lock and section at Rapide Croche	....	5,360 00	23,544 47	7,012 55	35,917 02
Dam embank, Grand Kaukana	$100 00	....	....	....	100 00
Enlarging canal at Little Chute	....	1,579 80	2,508 20	37 96	4,125 96
Rebuilding combined locks, Little Chute	....	....	....	10,625 01	10,625 01
Lock and section at Menasha	....	1,980 00	3,626 66	208 40	5,815 06
Lock and dam at Montello	....	14,360 00	5,203 65	....	19,563 65
Lock at Fort Winnebago	500 00	13,657 57	14,310 00	56 26	28,523 83
Lock at Portage City	....	....	897 07	....	897 07
Constructing dredges	302 99	11,721 22	11 11	253 36	12,288 68
Operating dredges	535 83	5,950 53	3,956 23	5,617 29	16,059 88
Wing-dams at Upper Fox	....	1,901 93	1,600 00	3,000 00	6,501 93
Lock-houses	20 20	1,050 19	....	....	1,070 39
Printing	152 00	107 20	....	....	259 20
Miscellaneous	901 94	532 30	2,550 45	788 66	4,7[illegible] 35
Navigation account	....	....	....	304 40	304 40
Water-power account	....	....	....	68 40	68 40
Land-damages	....	....	3,093 00	260 00	3,353 00
Engineering	2,212 56	10,294 33	8,635 25	7,354 33	28,496 47
Total construction	4,725 52	102,900 03	80,008 65	36,488 21	*224,129 41
Operating department	1,368 70	12,830 93	12,190 91	9,563 13	35,953 67
Total	6,094 22	115,730 96	92,199 56	46,051 34	260,076 08

* This total foots up $196 less than the footing given in the printed report from which it has been taken.

Expenditures from beginning of improvements in 1848 *to* 1859.—The following consolidated table shows all the expenditures from the beginning of the improvement in 1848 to 1859, distributed among the different parts of the work as far as the published data available will allow us to do it.

Statement of expenditures on the Fox and Wisconsin River improvement from 1848 to 1859, inclusive.

	Under the State prior to 1853.	Under improvement company in 1853–'54.	Under improvement company from 1854 to August 25, 1856.	Under improvement company from August 25, 1856, to 1859.	Total.	Remarks.
Depère	$1, 365 81	....	Distribution of this amount not known.	....	$1, 365 81	Improvement made by the water-power company.
Little Kaukana	....	....		$45, 370 11	45, 370 11	
Rapide Croche	26, 105 02	$292 00		35, 917 02	62, 314 04	
Grand Kaukana	37, 547 04	32, 902 21		100 00	70, 54[illegible] 25	
Little Chute	36, 631 21	50, 950 73		14, 750 97	102, 33[illegible] 91	
Cedar Rapids	25, 997 42	7, 546 17		....	33, 543 59	
Grand Chute	32, 469 67	42, 218 17		....	74, 687 84	
Winnebago Rapids (Menasha)	....	5, 817 53		5, 815 06	11, 632 59	Partly built by water-power company.
Upper Fox	26, 926 69	3, 833 16		54, 414 14	85, 173 99	Includes lock and dam at Montello, 1857 and 1858, and a few wing-dams, but mainly dredging.
Portage Canal	69, 754 02	....		29, 420 90	99, 174 92	
Wisconsin River	15, 105 39	....		....	15, 105 39	Surveys, wing-dams, snags, and trees.
Miscellaneous	156, 953 56	27, 301 63	$333, 944 46	38, 334 21	556, 533 86	
Totals	428, 855 83	170, 861 60	333, 944 46	224, 122 41	1, 157, [illegible] 30	

Mr. Seymour further states—

The work still proposed to be done is as follows:

Lengthening lock at Depére	$10,000
Enlarging canals on Lower Fox	2,000
Graveling dams	1,000
Completing lock and dam at Montello	12,000
Rebuilding lock at Portage	25,000
Building drawbridge at Portage	2,500
Enlarging canal at Portage	2,500
Wing-dams on Upper Fox at Portage	5,000
Dredging Upper Fox at Portage	7,000
Engineering and contingencies	8,000
Total	75,000

By reference to these tables, Mr. Seymour says—

It will be seen that a much larger amount has been expended than was contemplated in the report of September, 1856. There is still about $75,000 worth of work to be done, making the cost about $300,000 instead of $200,000, as specified in the report of 1856. This has occurred in consequence of a better class of work being done than was contemplated, and of many unforeseen contingencies which could not have been anticipated.

Mr. Seymour also states—

The company have paid out for State indebtedness and construction, since October 3, 1856, $181,539 more than they have received from the sales of lands and tolls.

The select committee of the legislature reported:

Your committee are of the opinion that the said improvement company have, considering the pecuniary embarrassments of the past two years, and the general depression of all kinds of business consequent thereon, done all that could reasonably be expected.

Operations in 1860–'61–'62; *report of superintendent of company.*—In these years, as far as I have learned, there was little done. The report of the superintendent of the company, dated August 18, 1862, makes the expenditure from January 1, 1860, to August 18, 1862, only $6,585.92. The amount of lands remaining unsold belonging to the company August 1, 1862, was 421,201.27 acres. This report says that—

The State and the company also insist that they are entitled, under the acts of Congress, to select for the *Wisconsin River* five sections for every mile of its improvement from Portage City to the Mississippi River, a distance of 113 miles, which would still further increase the quantity of lands about 362,000 acres.

Increased capacity necessary for passage of gunboats, &c.—On December 18, 1862, Mr. Jenné, at this time division engineer on the New York canals, made a report to the president, Mr. John F. Seymour, in relation to making the works of improvement of a capacity suitable for the passage of gunboats 144 feet long, 34 feet beam, and 6 feet draught, as follows:

On the Lower Fox:

Excavating dam at foot of the Depère lock		$10,000
Raising eight dams varying from 600 to 1,400 feet in length		30,000
Rebuilding one dam, 700 feet, at Grand Kaukana		12,000
Rebuilding four locks		104,000
Raising fourteen locks and new gates		66,000
Raising banks and protecting with wall five miles of canal		83,000
Excavating channel of river at Menasha and Neenah		25,000
Rebuilding guard-gates at Grand Kaukana and Menasha		10,000
Total		340,000
On the Upper Fox:		
Building five locks and dams	$150,000	
Dredging channel at different points and other necessary work	120,000	
Total		270,000

On canal and locks, Portage City:

Enlarging and deepening canal and protecting banks	$30,000	
Rebuilding guard lock and protecting head and cutting down breast-wall of lift-lock	30,000	
Total		$60,000

On Wisconsin River:

Building dams for contracting channel of river and other necessary work	$250,000	
Engineering and contingencies	80,000	
Total	333,000	
Grand total		1,000,000

He says:

Should it be considered advisable to make the locks of sufficient length to pass boats of 200 feet, it would be necessary to increase the length about 60 feet. The location of all the locks now built is such that the change can readily be made at a cost of $10,000 per lock. The whole cost would then be as follows:

Cost of improvement as per foregoing estimate	$1,000,000
Cost of lengthening 25 locks, $10,000 each	250,000
Total for boats 200 feet long	1,250,000

The above estimates are, in my opinion, ample for the work contemplated, which can all be done in two years.

In this report Mr. Jenné says:

The Wisconsin River has a descent of about 1 foot to the mile for 115 miles, is from 500 to 1,000 feet wide, and has a current of 2 miles per hour. The bed of the stream is of a sandy formation, and in many places has great width. This is a channel in all cases of from 5 to 6 feet in low water, but this being crooked, where the water spreads out, it requires to be reduced in width by means of the wing-dams, when the river will make its own channel as it recedes from high to low water. The work required to increase the depth of water in all the improvement, so that gunboats drawing 6 feet of water can navigate the same, will be as follows. * * *

The Wisconsin River would be improved by the continuation of wing-dams located so as to contract the shallow portions of the channel. The desired water-way may be further secured at low water by the constant passage of boats between the points at which sand may be deposited by the variable action of the current.

RENEWAL OF INTEREST IN THE IMPROVEMENT BY THE UNITED STATES.

During the third session of the Thirty-seventh Congress, a resolution in regard to this route was adopted by the House of Representatives, as follows:

Resolved, That the Committee on Naval Affairs is requested to inquire into and report upon the practicability and probable cost and time required to improve the Wisconsin and Fox Rivers, so as to give an uninterrupted navigation from the Mississippi River to Lake Michigan for vessels of war 200 feet in length, 34 feet beam, and drawing not less than 6 feet of water; and also to report such other facts relating to the defense of the lakes, and a suitable naval station thereon, as they may deem desirable for the information of the House.

Report of the Committee on Naval Affairs Thirty-seventy Congress, &c.—Mr. Pike, from the committee, made a report March 3, 1863. They had Mr. Jenné's estimate before them, and, it appears, conferred with Colonel Cram, United States Engineers. The report says:

Colonel Cram adds somewhat to Mr. Jenné's estimate, and gives as follows:

Probable estimate to pass a boat 200 feet long by 34 feet beam:

I would increase Mr. Jenné's estimate for his proposed method of improving the Lower Wisconsin, so as to allow a draught of 6 or 6½ feet, to	$315,000
And for the canal at Portage City, 6 or 6½ feet draught, to	70,000
And for the Upper Fox, 6 or 6½ feet draught, to	340,000
To which add the above estimate for an improvement in the Lower Fox for a draught of 12 feet, including the dredging of 24,000 cubic yards at the mouth of the Fox, (*sic*)	1,662,384
	2,387,384

The increase of depth in the Lower Fox to 22 feet was suggested for the purpose of making Lake Winnebago a naval station, which it was held by some would not be prohibited by the "treaty of 1817," but the committee regarded the treaty as practically covering this case. The report of the committee closes with the following enlarged views:

The true ground, as the committee think, upon which to place the propriety of yielding assistance to this Wisconsin enterprise, is its great natural importance in making cheaper and easier the intercourse between the grain-regions of the Northwest and the manufacturing and commercial States of the East. The expenditure of twenty millions in the completion of this work and that of Illinois, with a corresponding enlargement of the means of conveyance in the East, would be many times repaid in the increased general prosperity which would result from it. Whenever some systematic and well-matured plan shall be laid before Congress, which shall compass this result, it is to be hoped that it may be adopted.

Congress took no further action at that time on the proposition.

Company having failed to perform its agreement, the works of improvement, lands, &c., were sold in 1866.—In the summer of 1866 the "Fox and Wisconsin Improvement Company" have failed to perform fully its agreement with the State, the trustees sold the works of improvement, lands, franchises, &c., at public sale, thereby destroying this company.

Green Bay and Mississippi Canal Company, incorporated by the State August 15, 1866.—The purchasers were by act of the legislature permitted to organize themselves into a company, and they assumed the name of "The Green Bay and Mississippi Canal Company." The certificate of their incorporation is dated August 15, 1866.

Examinations and estimates ordered by Congress.—The act of Congress approved June 23, 1866, under which the survey of this route was placed under my charge, contained the following, which may be considered as intended to cover the expectations of that body in directing surveys and examinations of the Fox and Wisconsin Rivers:

And the Secretary of War * * * shall cause such needful examination of other harbors and places in the fourth section of this act specified, upon the sea and lake coasts and on Western rivers, to be made as will enable him to determine what improvements thereof are required to render them safe and convenient for the navigation of the naval and commercial vessels of the United States, and the cost of such improvements; and he shall make full report thereof, and of the plans deemed advisable therefor, to Congress at the commencement of the next session, for such action as may be judged expedient and right.

SEC. 4. * * * The Fox and Wisconsin Rivers, in the State of Wisconsin. * * *

Condition of these rivers and improvements, &c., in 1866.—Brevet Maj. C. R. Suter, to whom I intrusted the details of the examination, made his report, dated January 2, 1867. My report is dated January 21, 1867, and that of the Chief of Engineers and of the Secretary of War transmitting it to Congress are dated January 29, 1867; the whole printed as part of H. Ex. Doc. No. 58, second session of the Thirty-ninth Congress. As this was not repeated in any subsequent annual report, and not readily referred to, I abstract from it the following brief account of the condition of these rivers and the improvements on them at that date and the new works and repairs required.

Major Suter had assistance from Mr. N. M. Edwards, the chief engineer of the company, and was allowed to trace such copies from the maps of the company as were needed. These were not published with the report, and can now be seen with the files of the engineer headquarters.

Condition of the Lower Fox River improvement in 1866.—The Depère dam is located at the head of natural navigation of the Fox river, 5 miles above the town of Green Bay and 7 miles above the mouth of

the river. It is 1,400 feet long and 6 feet high, and in good order. The canal-section is 750 feet long, and forms a basin. The lock is composite, with wooden bottom, is 140 feet long, 35 feet wide, 17 feet high, 8 feet lift, with 4 feet 3 inches on the lower miter-sill. Four feet three inches is the greatest depth attained on the lower miter-sill, but when the wind blows out of Green Bay there is sometimes not more than 2 feet. This lock is very unsatisfactory. It is only 140 feet long, while all the others are 160 feet long. The pit should have been sunk at least 2 feet lower. A large piece of shoal water intervenes between the lock and the channel of the river. The bottom is solid rock.

The upper level has 6 feet or more depth of water to within half a mile of Little Kaukana lock, where it diminishes to 5 and 4.

Estimate.

To make 4 feet draught	$45,000
To make 6 feet draught up to the next lock, with locks 220 by 35 feet, will require	83,300

The Little Kaukana dam is 6 miles above Depère. It is 550 feet long and 6 feet high. It is quite level, but leaks considerably.

The canal leading around the dam is 1,166 feet long, with the lock at the lower end. The lock is composite, 160 feet long, 35 feet wide, 19 feet high, bottom of rock, head-walls of masonry, is in good condition, needing no repairs. It has 8 feet lift, with depth on lower miter-sill of 5 feet 8 inches.

The level above has about 4 feet depth, but the channel is quite crooked, and to be available for vessels of 4 feet draught the dam must be repaired and raised 1 foot; to make 6 feet draught the dam must be raised 3 feet and straightened; the canal-banks and the lock must also be raised, and the latter lengthened 60 feet for boats 220 feet long.

Estimate.

For securing 4 feet draught up to next lock	$3,000
For securing 6 feet draught, boats 220 feet long	27,736

The Rapide Croche dam is 6 miles above Little Kaukana. It is 440 feet long, 6 feet high, and in good condition. A canal 1,800 feet long runs from the dam across a point of land. At the lower end is a fine stone lock, the only one in the improvement, all the others being composite. It cost $60,000. The lock is 160 by 35 feet, 19 feet high, with 8 feet lift, and depth of 6 feet 6 inches on the lower miter-sill.

The level above has 5 feet depth to within half a mile of the upper end, where loose stones on the bottom cause the depth to vary between 3 and 5 feet. These stones must be removed.

To get 6 feet draught, the dam, canal-banks, and lock-wall should be raised 1 foot and the upper level cleared of loose stones. For vessels 220 feet long the lock must be lengthened 60 feet.

Estimate.

To make 4 feet draught up to next lock	$4,000
To make 6 feet draught for boats 220 feet long up to next lock	41,000

The Grand Kaukana dam is 4½ miles above the Rapide Croche It is 583 feet long and 6 feet high. It is in a very dilapidated condition and should be rebuilt. The canal around the rapids is 7,400 feet long, overcoming, by means of five locks, a fall of 50 feet. The average width of the canal on top is 130 feet, with two basins for boats to pass. These locks are all composite, 160 feet by 35 feet, with bottoms of rock.

First or upper lock: Height, 24 feet; lift, 9 feet; depth on lower miter-sill, 9 feet 4 inches. Needs new wood-work to upper section.

Second lock: Height, 20 feet 7 inches; lift, 10 feet; depth on lower miter-sill, 6 feet 2 inches. Needs new wood-work to the upper section and one pair of new gates.

Third lock: Height, 20 feet; lift, 11 feet; depth on lower miter-sill, 5 feet 1 inch. Needs new wood-work to upper section, and one new pair of gates.

Fourth lock: Height, 21 feet 4 inches; lift, 10 feet; depth on lower miter-sill, 6 feet. Needs new wood-work for upper section and four new gates.

Fifth lock: Height, 21 feet; lift, 10 feet; depth on lower miter-sill, 6 feet. Needs new wood-work for half the upper section.

The upper level up to Little Chute is over 5 feet deep.

The second, third, fourth, and fifth levels have a nearly uniform depth of about 5 feet.

To obtain water enough for 4 feet draught it will only be necessary to rebuild the dam and repair the locks.

For 6 feet draught for vessels 220 feet long it will be necessary to raise the dam and upper lock-walls and canal embankment above it 1 foot, also the walls of the fourth lock and the canal-banks on the level above, so as to make 6 feet on the miter-sill of the third lock. The levels will have to be dredged out and the locks lengthened 60 feet, for which there is sufficient space.

Estimate.

For 4 feet draught up to next rapid	$22,800
For 6 feet draught for vessels 220 feet long up to next rapid	111,670

The Little Chute dam is 2½ miles above Grand Kaukana dam. It is 690 feet long and 7 feet high. It has settled on the west end for one-quarter of its length from 1 to 12 inches. The canal is, below the dam, 6,467 feet long. The fall of 38 feet is overcome by four locks 160 by 35 feet, the two lowest ones combined. The least width of the canal is 100 feet on top, and there are several basins in which boats can pass each other.

Upper or lock No. 1 is 14½ feet high; has a lift of 4½ feet, with depth of 6 feet 1 inch on lower miter-sill; bottom, rock. Needs repairs on gates and new wood-work for upper section.

Lock No. 2 is 18 feet 4 inches high; lift, 10 feet; depth on lower miter-sill, 4 feet 10 inches; bottom, rock. Needs new lower gates and repairs on wood-work of upper section.

Lock No. 3: Height, 19 feet 3 inches; lift, 10 feet 9 inches; depth on lower miter-sill, 6 feet 5 inches; bottom of wood.

Lock No. 4: Height, 21 feet; lift, 12 feet 9 inches; depth on lower miter-sill, 6 feet 9 inches; bottom of wood. Upper sections of both 3 and 4 need repairing. The upper level has 6 feet draught or more, except in the mouth of the canal at the Cedars; at that point only 3½ feet. The second level is about 5 feet deep. The third level has 4 feet depth and upward. To make 4 feet draught it will only be necessary to level up the Little Chute dam. To make 6 feet draught, the dam and upper lock-walls and canal must be raised 2 feet. The three levels will need considerable dredging, and for vessels 220 feet long all the locks will have to be lengthened 60 feet.

Estimate.

For making 4 feet draught	$7,530
For making 6 feet draught for vessels 220 feet long	77,200

The Cedar Rapids dam is three-quarters of a mile above that at Little Chute. It is 470 feet long and 7 feet high. It has settled for about half its length from 1 to 18 inches. A canal 1,200 feet long, its banks faced with dry stone, leads around the dam with a lock 160 feet by 35 feet near its upper end. The lock is 19 feet high; lift, 10 feet; depth on lower miter-still, 3 feet 11 inches; the bottom is rock; head-walls, dry masonry. It needs new wood-work for the upper section and repairs to two gates. The upper level has a good depth, averaging about 5 feet to within a short distance of the paper-mill at Appleton lower lock. For a distance, say, 500 feet below the mill, it is barely 4 feet. To make 4 feet draught, leveling the dam is all that is necessary. To make 6 feet draught, the dam, canal-banks, and lock-walls must be raised one foot and considerable dredging done; and to allow vessels to pass, 220 feet long, will require the lock to be lengthened 60 feet.

Estimate.

For securing 4 feet draught	$3,930
For securing 6 feet draught for vessels 220 feet long	23,400

The Appleton Lower dam (Grand Chute) is 3 miles above that at the Cedar Rapids. It is 440 feet long and quite tight and level, and could not be raised without overflowing much valuable property. The dike on the Appleton side should be raised.

A canal 1,267 feet long leads around it, with the lock at the lower end of it 160 feet by 35 feet. This lock is 19 feet 3 inches high; lift, 8 feet 6 inches; depth on lower miter-sill, 6 feet 8 inches; bottom is of rock; wood-work is good; one gate needs replacing; it must be lengthened 60 feet for vessels 220 feet long. The level above will require some dredging to obtain 6 feet draught.

Estimate.

For 4 feet draught	Nothing.
For 6 feet draught for boats 220 feet long	$11,000

The Appleton Upper Dam (Grand Chute), about one-third of a mile above the Lower Dam, is 800 feet long and about 7 feet high. It is quite tight, but for about 430 feet of the middle portion has settled from 1 to 10 inches. A bulk-head about 1,000 feet long by 12 feet wide on top extends from the right-bank extremity of this dam, and forms the left bank of the canal. It is built, like the locks, of dry masonry, faced with itmber, which is decayed, and the whole should be replaced by good stone masonry.

The canal is carried from the lower end of the bulk-head across a point of land a distance of 3,600 feet. In this portion there are three locks, 160 by 35 feet each, having a total lift of 29½ feet.

The first or upper lock is 23 feet high; lift, 7 feet 9 inches; depth of water on lower miter-sill, 8½ feet; bottom is of rock. Needs a pair of gates, new wood-work for upper section, and relaying of right-hand wing-wall. The second lock is 22 feet 2 inches high; lift, 11 feet 9 inches; depth of water on lower miter-sill, 4½ feet. Needs new pair of gates and new wood-work on upper section. The third lock is 22 feet 1 inch high; lift is 10 feet; depth on lower miter-sill 8 feet 8 inches. Needs one pair of gates and new wood-work on upper section. The upper level has over 6 feet till within about 900 feet of the Menasha lock; for about 300 feet of this distance there is only 3 to 3½ feet. The other levels are designed for 4 feet, but have all got somewhat filled up and will need dredging. The lock-walls and canal-banks at the third

lock will need raising to secure 6 feet draught on the miter-sill above, and all must be lengthened 60 feet for boats of 220 feet length.

Estimate.

For securing depth of 4 feet	$18,870
For securing depth of 6 feet for boats 220 feet long	63,870

The Menasha Channel (Winnebago Rapids) is on the right-bank side of Doty's Island, which here divides the stream. The dam is about 5 miles above the upper dam at Appleton. It is 460 feet long and 6 feet high and in good order. The canal around the rapid is about three-quarters of a mile long, and the lock is situated at the lower end. Numerous mills, situated along this canal, draw their water from it. These mills now draw more water than they are entitled to, and so lower the depth for navigable purposes; that while there is six feet draught at the upper end of the canal, there is but 3 feet at the lower end. The lock is composite, 160 by 35 feet; the lift is 10 feet, and the depth on the lower miter-sill is 6 feet 2 inches. The upper section of planking and timbers need renewing and the gates repairing. The locks will have to be lengthened 60 feet for vessels 220 feet long. The entrance to the canal is obstructed above by two bars. The outer one is composed of sand and can be dredged; but the inner one, being composed of stiff, hard clay, mixed with gravel and covered with bowlders, will require to be coffer-dammed and dug out by hand. This channel, however, is much better than the other or Neenah Channel, and at present is the only one used for navigation.

Estimate.

For making 4 feet draught	$13,270
For making 6 feet draught with locks 220 feet long	54,200

The Lower Fox forms the outlet of Lake Winnebago, a body of water 35 miles long, from 9 to 14 miles wide, with depths varying in the deepest parts from 12 to 25 feet. Over the 15½ miles of lake navigation, between the Upper and Lower Fox Rivers, there is a depth of over 20 feet. This lake is a great reservoir, and prevents any sudden changes in the volume of the outlet from freshets—the extreme fluctuations in the Lower Fox not exceeding 3 to 4 feet. The level of the lake does not reach more than 3½ feet above the ordinary level maintained by the dams at the outlets, but it is occasionally drawn down by the water-power mills nearly 2½ feet below this level. The total fall from Lake Winnebago to Green Bay is about 170 feet, and the distance 37½ miles. The minimum volume of the Lower Fox is given by Mr. Westbrook at 2,320 cubic feet per second.

The following table is made up from the figures of Major Suter's report, as modified by me in arrangement in the foregoing abstract:

Table in regard to the Lower Fox River in the autumn of 1867.

Place.	Intermediate distance.	Distance from mouth of river.	Number of locks.	Elevation overcome.	Height above Green Bay.	Cost of making navigation from one dam to next above. For 4 feet draught, locks 160 x 35.	Cost of making navigation from one dam to next above. For 6 feet draught, locks 220 x 35.
	Miles.	*Miles.*		*Feet.*	*Feet.*		
Depère dam	7	7	1	8	8	$15,000 00	$83,300 00
Little Kaukana, dam	6	13	1	8	16	3,000 00	27,730 00
Rapide Croche, dam	6	19	1	8	24	4,000 00	41,000 00
Grand Kaukana, dam	4½	23½	5	50	74	22,800 00	111,670 00
Little Chute, dam	2½	26	4	38	112	17,530 00	77,200 00
Cedars, dam	0¾	26¾	1	10	122	3,930 00	23,400 00
Appleton, lower dam	3	29¾	1	8½	130½	....	11,000 00
Appleton, upper dam	0¾	30½	3	29½	160	18,870 00	63,870 00
Menasha, dam	5	35½	1	10	170	13,270 00	54,200 00
Lake Winnebago	2	37½	......	......	170	....	....
Total	37½	......	18	170	......	118,400 00	493,370 00

Condition of the Upper Fox River and improvements in 1866.—The present traveled route between Oshkosh and Fort Winnebago is 104 miles, the air-line being 54 miles. As near as can be estimated, there have been 18,000 feet of cut-offs by dredging, making a saving of about three-fifths of the distance. The total fall is about $33\frac{1}{10}$ feet. In most places there is a fall of a foot in 2½ miles, but there are long reaches where the fall is scarcely perceptible. Several lakes occur on the course of the river, which are generally shallow and full of wild rice.

The mouth of the Fox River at Oshkosh is very deep; the channel has upward of 20 feet of water, which continues along the whole river-front of the town; thence to Lake Buttes des Morts, and through that lake there is over 12 feet of water; the river is broad and deep, with no perceptible current. About 10 miles from Oshkosh the Fox is joined by the Wolf River, a stream of nearly its own size. This river is navigable for about 50 miles; it penetrates into the lumber regions in the northern part of the State, and a great quantity of logs and sawed lumber is floated down the river to Oshkosh.

After passing the mouth of Wolf River 6 feet is the least depth until we reach Omro Bar, half a mile below the town of that name; thence to the town, 4½ feet of water. This portion of the river is quite crooked, but this is of no great importance to small vessels, on account of the depth of the water. Two miles below Omro a cut about a mile long, carrying the waters of the Fox straight to Lake Buttes des Morts, would save 7 or 8 miles of distance. From Omro to Delhi there is about 5 feet of water; never less, except in small spots. Above Delhi there is the same depth to Eureka Bar. From here to the town of Eureka, 1½ miles, there is only from 4 to 4½ feet, with occasional deep spots. In front of the town there is 6 feet of water. At Eureka there is a permanent bridge, the only one between Berlin and Oshkosh. There are several floating bridges, however, where country roads cross the river. From Eureka to Sacramento there is an average depth of 6 feet. The river is quite narrow.

Above Sacramento there is an average depth of 5 feet half-way to

Berlin; then from 4 to 4½ feet as far as a floating bridge three-quarters of a mile below Berlin. Above this bridge, and also in front of the town of Berlin, there is about 5 feet of water. Between Sacramento and Berlin there is not much marsh along the river, and the banks are generally high. Above Berlin, the average depth is from 5 feet to 6 feet for 8 miles. At this point there is a short bar on which the water is only 3½ feet deep. The average depth above here is from 5 feet to 6 feet, until the mouth of the Puckeyan River is reached. Just above the mouth of this stream is a short bar with 3½ feet of water. At the lower end of Willow Bend is another short bar with 3½ feet of water. At the mouth of White River is a bad bar 300 yards long, and having only 3 feet of water on it. In the west side of the first bend above White River is a flat bar caused by a sudden widening of the stream. It is 200 yards long, and has 3½ feet of water on it. (The lowermost wing-dam is about 2 miles below State Centre.) There is a bar below this lower wing-dam with 3 feet of water. Above this wing-dam there is from 3½ feet to 4½ feet of water; usually 4 feet and often more. The banks of the stream from Berlin to the lower wing-dam are generally low and marshy, but above this point they are quite high, and continue so to the mouth of the Mechan River. There is a second wing-dam at State Centre. At Saint Mary are the ruins of a bridge. From Saint Mary to Princeton the river is quite shoal. The average depth is 4 feet, but on the bars there is less than 3 feet. There are two more wing-dams at Princeton. There is also at this point a good, permanent bridge across the Fox.

Between Princeton and the mouth of Mechan River there are three wing-dams. In this portion of the river the water is quite shoal, not more than 3 feet deep. From Omro to the mouth of Mechan River the fall is about 1 foot in 2½ miles, and there is quite a strong current. Above Mechan there is slackwater to Lake Puckaway. The river is very wide, with 6 feet or 8 feet depth of water or more. Within the Big Bend, above Princeton, the ground is quite high, about 30 feet above the level of the river. If a canal could be cut through here about 10 miles would be saved, as the neck is only a mile wide.

Lake Puckaway is a sheet of water 8¼ miles long and from 1 to 2 miles wide. The lower end of the lake is very shallow and full of reeds and wild rice. A channel, running northeast from Marquette, has been cut through for steamers. It is from 3 feet to 3½ feet deep. A channel, having 4 feet of water, leads along the eastern shore of the lake. The bottom of the lake is very soft, black mud, through which a channel of any depth can be easily dredged For about a mile to the westward of Marquette the lake is filled with rushes. A channel exists, however, which has about 4½ feet of water. After getting out of the rushes, there is from 5 feet to 6 feet of water to the end of the lake.

At the mouth of the Fox, that is, where it enters Lake Puckaway, there is a bar half a mile long, where there is only from 3 feet to 3½ feet of water; above this there is 5 feet or 6 feet for about 3 miles. Just below the large bend there is about 4½ feet; then for a mile from 6 feet to 7 feet. The rest of the way to Montello the river is shallow. Three and a half feet is the average depth, and 3 feet is the least. There are a good many sand-banks just below Montello which wash into the stream and cause bad bars. The current between the lakes is quite rapid.

At Montello, a lock and dam are being constructed to raise the water above Lake Buffalo. As shown by the plan, it is designed to cut the canal through into a bayou, which has a depth of about 7 feet. The Montello River has also been turned into this bayou.

The dimensions of the lock, dam, and canal, when finished, will be as follows: Dam, 151 feet long; canal, 650 feet long and 90 feet wide; lock-lift, 3 feet; depth on lower miter-sill, between 8 feet and 9 feet; height of lock, 15 feet; length, 160 feet; width, 35 feet; composite lock, with head-walls of masonry.

Above the mouth of Montello River there is from 4 to 4½ feet of water as far as the lower end of Lake Buffalo. Lake Buffalo is a large rice-field, about 13½ miles long and half a mile wide. The Fox crosses it in a very tortuous but deep channel. After entering the lake there is from 6 feet to 9 feet as far as Packwaukee, and even as deep as 15 feet. There is a pile-bridge across the lake at Packwaukee. From Packwaukee a good channel leads to the end of Buffalo Lake. The water runs from 7 feet to 9 feet in depth. Between Lake Buffalo and Lake Menomin there is a channel of about the same depth, and also through Lake Menomin. This channel is exceedingly crooked. Lake Menomin is a large wild-rice field like Lake Buffalo. It is 1½ miles long by half a mile wide. After leaving this lake, and especially after passing Merritt's Landing, just above Moundville, a series of small, but bad, bars are met with. They are caused by the washing of a high sand-bluff on the river-bank. These bars have barely 3 feet of water on them. The worst of them could be avoided by a cut-off. In the last mile below Roslyn the channel is as a general rule quite deep, from 6 to 8 feet; but shoal spots occur, where only 4½ feet is to be found. The channel is exceedingly crooked and narrow. A great many cut-offs should be made in this portion of the river.

From Roslyn to the first cut-off there is from 5½ feet to 7 feet of water. Just below this cut-off is a short bar with only 3 feet of water. In the cut itself there is about 4 feet. Above the cut is another bar with 3 feet depth. This first cut-off is only about 40 feet long; but it saves nearly a mile of distance. From the first to the second cut-off the depth is about 4½ feet. In the cut-off there is a bar with about 3 feet of water. The rest of the cut has a depth of about 4½ feet. From the second to the long cut-off there is from 6 feet to 9 feet of water. At the lower end of the long cut-off there is 5 feet of water; at the middle, 4 feet; at the upper end, 3 feet, with a short bar having from 2 feet 8 inches to 3 feet. From the end of the cut-off to Governor's Bend lock there is about 5 feet of water. Between Governor's Bend lock and Roslyn the stream is very crooked, and several long cut-offs should be made. The cut-off just below Governor's Bend is about a mile long, and saves about 3 miles. Governor's Bend lock, dam about 4 feet high and 60 feet long. Canal, 570 feet long and 57 feet wide. Lock, composite; lift, 4 feet; depth on lower miter-sill, 5 feet 6 inches; height 15 feet; length, 160 feet; width, 35 feet; new and in good order. From this lock to Winnebago lock there is slackwater. The channel leads almost entirely through cut-offs, and is quite free from sharp bends. The width of these cut-offs is about 60 feet. The depth will average 4½ feet to within a mile of Winnebago lock. In this last distance the channel is full of sand-bars. The water gradually shoals from 4½ feet to 2½ feet. At the foot of Winnebago lock there is 8 feet of water.

At Winnebago lock the lift is 7 feet; depth on lower miter-sill, 6 feet 1 inch; height, 17 feet; length, 160 feet; width, 35 feet. Composite lock with masonry head-walls; all in good order.

The canal which connects the Fox and Wisconsin Rivers is quite shoal. At the lower end it is 5 feet deep for about 200 feet; then 3 feet deep to within 500 feet of the first railroad-bridge; then 2½ feet deep to the second railroad-bridge; then 2 feet deep to the town of Portage. At the

upper or Wisconsin end it is about 18 inches deep. The mill at the lower end draws the water down about 1 foot. At the upper end of the canal is a guard-lock, which is used as a lift-lock when the Wisconsin is high. It is in a very dilapidated condition, and should be rebuilt. It is 2¼ miles (12,400 feet) in length, and 75 feet in width. It is cut through a flat, sandy plain which separates the waters of the Fox from those of the Wisconsin. The Fox River is about 5 feet lower than the Wisconsin in ordinary stages of water. During high water the Wisconsin overflows this neck of low ground at Portage, and also 5 or 6 miles above, and a large portion of its waters are thus diverted to Green Bay. The spring-rise in the Fox is principally owing to this cause, for the Fox itself fluctuates very little. About 7 miles below Portage a stream called Big Slough comes into the Fox. During high water this connects with the Wisconsin and becomes a very considerable stream, bringing a large volume of water into the Fox. In fact, the greater part of the low country between the two rivers is overflowed by the Wisconsin at this time. It will be seen that the canal is not straight, but makes a considerable bend to the westward. The object of this was to place the mouth of the canal on the Wisconsin side, above an island. It was afterward proposed to give it a different direction, but the idea has never been carried out. At present the main bulk of the Wisconsin runs through the inshore channel, and the whole of it can be diverted through there if desirable. It is also much easier to protect the mouth of the canal in the proposed position than in the one it occupies at present. But the change is not a matter of any great importance.

The canal at present is almost filled up with sand, but it is being dredged out.

The only plan of improvement of the Upper Fox River which gives promise of permanency is to create slackwater navigation throughout the whole length of the stream by means of locks and dams. As a great deal of valuable property would be overflowed and ruined by putting in high dams and locks of great lift, it appears preferable to use low dams, say 3 feet high, and then lower the bed of the stream above and below the dam by dredging sufficiently to destroy the current. Further dredging will give the requisite depth for navigation, and the channel thus made will remain permanent.

Three locks appear necessary between the mouth of Mechan River and Omro. Above the former and below the latter point there is slackwater already, or will be when certain improvements in progress are finished; notably the Montello lock and dam.

The total fall between Mechan River and a point 1½ miles above Eureka is 12.87 feet, which it is proposed to distribute as follows: One lock at Princeton, 4 feet lift; one lock at Fiddler's Bend, 4 feet lift; and one lock 1½ miles above Eureka, 5 feet lift.

Ten feet of this total lift is included in the 12.87 feet, the remainder of that sum being allowed for backwater and flowage.

Details from Winnebago lock to Governor's Bend lock: distance, 5½ miles; fall not accurately known, as the bed of the stream has been much lowered by dredging since the last survey was made. The lock has about 4 feet lift, so that the fall is probably between 4 and 5 feet. Slackwater exists above Governor's Bend dam.

Governor's Bend lock to Montello lock: distance, 21 miles; fall, 5.95 feet, as nearly as can be computed. This is thought to be too much. The Montello dam is to raise the water 3 feet, and it is proposed to lower the bed below Governor's Bend lock 1 foot by dredging. This will, it is hoped, give slackwater back to Governor's Bend lock; but, in case it does

not, the Montello dam can be raised 1 foot more. It will probably be necessary to lower the bed of Governor's Bend lock 2 feet to enable a vessel drawing 6 feet of water to get through it; but this cannot be stated positively until a new set of levels has been run to ascertain the exact amount. The Montello dam can be raised, if necessary, without overflowing a great extent of country.

From Montello lock to head of Lake Puckaway: distance, 7 miles; fall, 4.93 feet. Bed of stream to be lowered 4 feet by dredging below the Montello lock, leaving .93 foot fall in 7 miles, or about .13 foot to the mile. From the head of Lake Puckaway to the mouth of Mechan River there is slackwater.

From mouth of Mechan River to Princeton lock: distance, 5¾ miles; fall, 2.57 feet. Water to be raised 2 feet by a dam, and lowered below the dam 2 feet by dredging. Lock, 4 feet lift; flowage, .57 foot.

Princeton lock to Fiddler's Bend lock: distance, 12 miles; fall from foot of Princeton lock, 2.92 feet. Water to be raised 2 feet by the dam, and lowered 2 feet below the dam by dredging. Lock, 4 feet lift; flowage, .92 foot.

Fiddler's Bend lock to Eureka lock: distance, 15¼ miles; fall from foot of Fiddler's Bend lock, 3.38 feet. Water to be raised 2 feet by a dam, and lowered below the dam 3 feet by dredging. Lock, 5 feet lift; flowage, 1.38 feet.

From Eureka lock to Oshkosh: distance, 24 miles; fall, 5.80 feet. Water to be lowered 3 feet at upper end of level by dredging, as stated for Eureka lock. This will reduce the fall 2.80 feet in 24 miles, or a little less than .12 foot to the mile, which is practically slackwater.

The volume of the Upper Fox at low water is not stated by Major Suter, nor have I seen it stated for any point of its course. At the lock near Fort Winnebago it is a very small stream at low water, merely sufficing as a feeder to slackwater navigation. Its amount is of no practical importance in this view, for any needed supply can be drawn from the Wisconsin River, which is the feeder for the canal connecting the two streams.

Major Suter states the lift of the lock at Fort Winnebago to be 7 feet, and the height of the Wisconsin above the Fox at this point to be 9½ feet. This fall of 2½ feet in 2½ miles is inadmissible in a canal for navigation, and is only allowable for supplying water-power. The guard-lock at the head of the canal communicating with the Wisconsin is also a lift-lock even at low water, and enables vessels to pass into the Wisconsin. To the preceding amount of elevation between the Wisconsin and Lake Winnebago, as stated by Major Suter, must be added 2½ feet for the Portage Canal guard-lock, and he makes this allowance in his table of total elevations.

Table of estimates given by Major Suter, United States Engineers, for the improvement of the Upper Fox River and Portage Canal, with distances and elevations.

	Distance apart.	Total distance.	Fall of water between places.	Elevations above Lake Winnebago.	For draught of 4 feet locks 160 feet by 35 feet.	For draught of 6 feet locks 220 feet by 35 feet.
	Miles.	*Miles.*	*Feet.*	*Feet.*		
Oshkosh to Eureka	22½	22½	5.20	5.20	$9,400	$31,400
Eureka to Fiddler's Bend	16½	39	5.98	11.80	71,673	151,873
Fiddler's Bend to Princeton	12½	51½	4.92	16.10	67,400	114,8[illegible]
Princeton to Mechan River	5½	57	2.57	18.67	57,654	105,506
Mechan River to head of Lake Puckaway	6½	63½	0.95	19.62	....	32,[illegible]52
Head of Lake Puckaway to Montello	15¼	78¾	4.93	24.55	35,209	79,005
Montello to Governor's Bend lock	21	99¾	5.95	30.50	40,000	[illegible]8,466
Governor's Bend lock to Fort Winnebago	5¼	105	2.60	33.10	4,693	50,505
Fort Winnebago to Wisconsin River (Portage Canal)	2½	107½	9.51	42.61	40,000	80,600
Total	....	....	....	....	326,02[illegible]	735,095

Condition of the Wisconsin River in **1866.—Major Suter's report says:**

On reaching the Wisconsin River the season was so far advanced that I was obliged to limit myself to a cursory examination of the stream, with a view of determining its general characteristics, the feasibility of rendering it navigable, and the best means of attaining this end. The river when I started from Portage City was about a foot above low-water level for this season. During the time occupied by my examination, it fluctuated between this height and 6 inches lower. The soundings and cross-sections taken can therefore only be relied on as giving a general idea of the volume of water in the river and the depth of its channel. No reliable survey has ever been made of this river. Its exact length, even from Portage to its mouth, is not known, but is given differently by various authorities, who all base their conclusions on the Land-Office maps. The length which I have assumed is believed to be nearest the truth. The total fall between the same points is also a matter of conjecture. I took twelve observations at intervals of about 10 miles, to determine the fall per mile, and the mean of these observations is probably very nearly exact. I give here the length, total fall, and fall per mile, as given by different authorities.

To avoid repetitions, and to enable comparisons to be made here of the value of these determinations and those given by others, the following table has been made. The exact measurements made by our survey in 1867 are added:

Table of different estimates and measurements of length, slope, and total fall of the Wisconsin River below Portage.

Authority.	Length in miles.	Fall per mile.	Total fall.
		Feet.	*Feet.*
Mr. C. D. Westbrook, civil engineer, from levels furnished by railroad companies in 1854	137	0.95	131.00
Silliman's Journal, altitude by barometer	....	.63	....
Mr. D. C. Jenné, civil engineer, chief engineer of Fox and Wisconsin Improvement Company	115	1.00	115.00
Levels furnished Major Suter by railroad companies in 1866	....	....	179.00
Lengths taken by Major Suter from latest editions of State sectional maps, the fall per mile a mean of twelve observations, from which the total fall is deduced	112	1.34	150.08
Determined by our survey made in 1867	118¾	1.50	178.00

The result of our survey in 1867 thus appears to be nearly the same as that given by the railroad company—the most unfavorable of all for an improvement of the navigation.

This being the case, we must be prepared to make some allowance for the favorable view of the navigation held by Major Suter, and a still greater one for the views advanced by the canal company's engineers and officers, under the influence of the idea that the slope was so much less on the average than it really is.

It is not my intention to quote connectedly from Major Suter's report on the Wisconsin, as the data obtained by him were necessarily very imperfect, and he recommended that a thorough survey should be made. The views he expressed were derived from imperfect data, and although they may be quoted by others hereafter as more favorable than those entertained by me, I refrain from doing it, because I think it would be unjust to him. He submitted an estimate for a thorough survey, but none for any improvement. He thought that with low wing dams 6 feet draught could be had.

In my report submitting Major Suter's, I said:

I have not as favorable an opinion as Major Suter has of the beneficial effect of dams, and I have estimated for the expense of applying boats to operate directly on the bars, to ascertain the improvement susceptible by that means. This was one of the means suggested by him. The sands of the Wisconsin River bars are easily moved by the water, they being free from any cementing material. I believe a low-water navigation of 3 feet throughout would be all that at present can be promised.

The survey that I made in 1866 at the mouth of the Wisconsin gave a depth over the bar of only 16 inches.

With the low-water depth of the Wisconsin secured at 3 feet, we might rely much of the time on 4 to 6 feet for average stages.

The locks on the Fox River improvements are designed for 4 feet draught, and it seems questionable whether it would do to undertake increasing this depth before its availability on the Wisconsin was demonstrated. Products passing from the Mississippi to the east through the lakes must break bulk before reaching its destination. No vessel suitable for these upper rivers would be able to navigate Lake Michigan, nor could the lake vessels in ordinary river-stages float on the Upper Mississippi. Therefore, for a through traffic it would seem best to adapt the improved connecting channel to the size of the grain-barges of the Mississippi. The dimensions of tow-boats need not exceed them.

WORKS OF IMPROVEMENT, ETC., IN THE YEAR 1867

In accordance with the recommendations of my report, an appropriation of $40,000 was made and approved March 2, 1867. An allowance was also made from the item for survey of western and northwestern rivers, to enable me to make a survey from Portage to the mouth of the Wisconsin River.

The procurement of a boat especially designed for the Wisconsin was deferred till a better knowledge of it was gained, and until the result of operations with similar boats on the Mississippi River could be obtained. This was all that was attempted on the Wisconsin River.

The Green Bay and Mississippi Canal Company, during the year, executed several needed works of repair, and continued dredging the channel on the Fox River and the canals around the dams. I have not seen their annual report, but learned from the chief engineer that the dam and lock at Montello were completed, the lock being composite, and costing $19,000. The dams in connection with it cost $9,000.

WORKS OF IMPROVEMENT IN THE YEAR 1868.

This year the Green Bay and Mississippi Improvement Company continued their works of repair and dredging on the Fox River. I person-

ally examined the line of the Fox River, and purchased at Oshkosh the small side-wheel steamer Winneconne, which was supplied with a powerful engine and a spool geared to connect with it, thought to be of great service in pulling snags and warping the boat across shoals. Her dimensions were: length, 84 feet; breadth, 24; draught, light, 2 feet. This vessel had but little difficulty in passing up the Upper Fox, although drawing all the water there was on the bars; but it took a great deal of trouble to get her down the Wisconsin River at all, and she was unable to pass Prairie du Bay till after a rise took place. We were unable to make any use of her, worth naming, that season.

In October an attempt was made to employ the Caffrey (one of the Mississippi dredge-boats) on the lower part of the Wisconsin, she having been satisfactory on the Mississippi. It was found, however, that she could not get into the Wisconsin. She drew about 32 inches, and was 150 feet long by 30 wide, with side-wheels. Only 2 feet water on the bars could then be found for 6 miles up the Wisconsin. (See pp. 203 and 204 Annual Report of Chief of Engineers for 1869.)

Much additional information about the valley of the Wisconsin River was gained this year by Capt. D. W. Wellman, after he had submitted his report, which is printed with that of the Chief of Engineers for 1868. (See pp. 351 to 356.) In this report he favored a canal along the valley more than any other method of improvement.

WORKS OF IMPROVEMENT IN 1869.

During September and October the Winneconne was employed (with two barges to carry fuel and working apparatus so as to secure least possible draught) in removing snags from the Wisconsin between Portage and Sauk, and this enabled two small stern-wheel vessels to make trips on this portion of the Wisconsin.

I again made a thorough personal examination of it in company with Mr. Jacob Blickensderfer, jr., an experienced canal engineer, and with his assistance planned the estimate for a canal along the valley, submitted with this final report. I believe no work was done by the canal company beyond repairs immediately needed.

CONCLUDING REMARKS TO CHAPTER III.

My views in regard to the improvement of the Wisconsin differ so much from those generally held heretofore that I have felt called upon to write this chapter, so that others can see by it the reasons for those previous views and compare it with my own; and as the Wisconsin forms only part of the route, I have thought it necessary to give an account of the other portion and how its improvement has been carried on, so that in adopting a final plan for a through route of water-transportation the whole subject may be presented for consideration. The endeavor has been to make this presentation as complete as possible, because the documents from which it is mostly obtained are not available for general consultation.

CHAPTER IV.

REPRESENTATION OF SURVEYS MADE IN 1867-'68-'69; THEIR OBJECT AND EXTENT; MAPS AND DIAGRAMS CONSTRUCTED FROM MEASUREMENTS; TABLES OF HYDRAULIC DATA; ANOMALOUS PHYSICAL FEATURES CONSIDERED AND REFERRED TO A GENERALIZATION OF SIMILAR EXHIBITIONS ELSEWHERE.

Preparations for the survey—Instructions for conducting the surveys—DESCRIPTION OF THE MAPS AND DIAGRAMS MADE FROM THE SURVEYS—Continuous plot, scale 200 feet to an inch—Cross-sections of the valley, scales 400 feet horizontally and 40 feet vertically to the inch—Longitudinal profile of the valley—Plots of current measurements for volume—Map of river on a scale of two inches to the mile—General map of the route from Green Bay to the Mississippi River—Sheets of river-gauge curves—GENERAL DESCRIPTION OF THE BASIN OF THE WISCONSIN RIVER—Form of basin, geographical position, &c.—General elevation above the sea—Geological formations in the basin—Climate—DESCRIPTION OF FEATURES OF THE VALLEY—Definition of term valley, &c.—Slopes and terraces not overflowed at high water—Marginal land and islands overflowed at high water—THE RIVER-BED—Sand-bars, &c.—Their formation—Action at low water—Very bad sand-bars in the Mississippi below the Wisconsin—Very bad sand-bars on the Wisconsin at the junction—Movement of sand-bars down stream—Sources and quality of the sand—Comparison of the Wisconsin sand with other water-moved sands—Gravel and bowlders in river-bed—Falling of trees and snags—Bed-rock—BRIDGES—HIGH AND LOW WATER STAGES AND THEIR DURATION—ICE—SLOPE OF WATER-SURFACE—Table of measured slopes at low water—BEND EFFECT—VOLUME OF DISCHARGE—Method of measuring volumes—Table of measured and low-water volumes—Explanation of construction of table—Volumes at a stage one foot above the low water of 1867—Volumes at Skinner's Bluff for all stages—ANOMALOUS PHYSICAL FEATURES OF THE WISCONSIN AND FOX RIVER BASINS—The near approach of the streams without uniting—Peculiarities in the course of the Wisconsin—Peculiarities in the course of the Upper Fox River—Lower Fox River—Analogies between the Lake Winnebago basin and the Lake Winnipeg basin in British America—Probable former extent of Lake Winnebago, with diagram—Hypothesis consistent with above-noted conditions—Previous attempts at generalization in regard to Fox River—PROBABLE CHANGE OF DRAINAGE OF THE FOUR LAKES NEAR MADISON—Explained by the same hypothesis which is applicable to an extensive area.

Preparations for the survey.—The examination of the Wisconsin and Fox River route in 1866 had shown that we were very well informed in every respect concerning the portion in charge of the Green Bay and Mississippi Canal Company, along the Lower and Upper Fox Rivers, and the canal at Portage, but that we had no good survey of the part along the Wisconsin River. It was designed, therefore, to make as thorough asurvey as possible of that river from the Portage Canal to the Mississippi during the season of 1867.

Early in August gauges were set up and observers engaged to constantly record the height of the water at the following-named places: At Kilbourn City, about 20 miles above Portage; at Portage; at Sauk City, 29 miles below Portage; at upper railroad-bridge, 25 miles below Sauk City; at Muscoda, 23 miles below the upper railroad-bridge; at the lower railroad-bridge, 21 miles below Muscoda; and at Bridgeport, 14 miles farther down.

This last place is but 6 miles above the junction with the Mississippi, and within the range of backwater from floods in this latter river. These gauges were observed till the river was closed by ice, about the 1st of December. They were also continued at Portage; upper and lower railroad-bridges, in 1868, from April to December; and at the upper and lower railroad-bridges in 1869 till December. In these years the river was open from the first part of April to the first part of December. These gauge-observations, as plotted, accompany this report. Observations on the Mississippi, at Prairie du Chien, and on Lake Winnebago, are shown at the same time for comparison. These

three years (1867–'68–'69) gave an average volume of water above the promise of years in general, as to the amount of water flowing along the Wisconsin and neighboring streams.

As it was desirable to conduct the survey at low water, the first part of the summer of 1867 was used in preparations, such as fitting up a large flat scow with a cabin, to serve as a quarter-boat for the surveying party, and in obtaining instruments, note-books, &c.

Instructions for conducting the survey.—The work was executed so nearly in accordance with instructions that I cannot better describe it than by inserting the instructions issued by me August 10, 1867:

UNITED STATES ENGINEER OFFICE,
Saint Paul, Minn., August 10, 1867.

The survey of the Wisconsin River will extend from Kilbourn City to its junction with the Mississippi. It is designed to have the maps and report exhibit all the information required for a thorough consideration of the subject of improving its navigation at low stages and determining the best plan of executing it.

If this improvement may be made by deepening the water on the bars by means of scrapers in excavating or by wing and longitudinal dams to prevent such bars from forming or cause their removal when formed; if by closing up one or more of the channels we can produce a sufficiency in the desired one; or, if these must all fail and resort be had to slackwater by dams with locks, or by continuous canal with locks along the valley, must also be determined, if possible, from the survey; and also the relative advantages of different methods in economical construction and practical value, when made.

The quality of navigation sought is such as will adequately meet the wants of a great line of communication from the Mississippi River to Lake Michigan along this river, the Upper Fox River, Lake Winnebago, Lower Fox River, and Green Bay. The existing information contains but very little that is conclusive concerning the engineering question involved. Nothing, therefore, must be relied on from other sources than this survey, and nothing left undone that circumstances of time and ability will enable the surveying parties to do.

The general features of the valleys of the northwestern rivers must be always kept in mind by the different engineers employed, and they are readily appreciated by reference to the following section and map, Plate II.

The main features observable are, first, a high bluff on each side of the river-valley, from 1 to 10 miles apart, and from 100 to 400 feet high, composed mainly of horizontally-stratified rock, and, in the case of the Wisconsin, of magnesian limestone of the Silurian formation. The slopes, however, are often covered with earth and grass, so that the rock is discernible to common observation only at places where quarries have been opened.

The second feature is a level or nearly level terrace, mainly composed of sand, though occasionally having a rich surface-soil. Towns are frequently located upon it. This terrace is from 20 to 60 feet above the level of the water; it is never continuous throughout the valley on either side, and rarely of much extent on but one side at a time. It is, probably, the shallow parts of an ancient water-course which once occupied the valley from bluff to bluff. It is now generally above overflow.

The third feature is the bottom-lands of the river, generally overflowed at highest stages, and having the high bluff or terrace for their margin. This bottom contains many lakes and marshes, and is cut up by sloughs forming islands, which sometimes divide the main stream into nearly equal parts. The margins of these bottom-lands are, in the natural state, generally wooded, and form the banks of the stream at moderate stages when the sand-bars are covered.

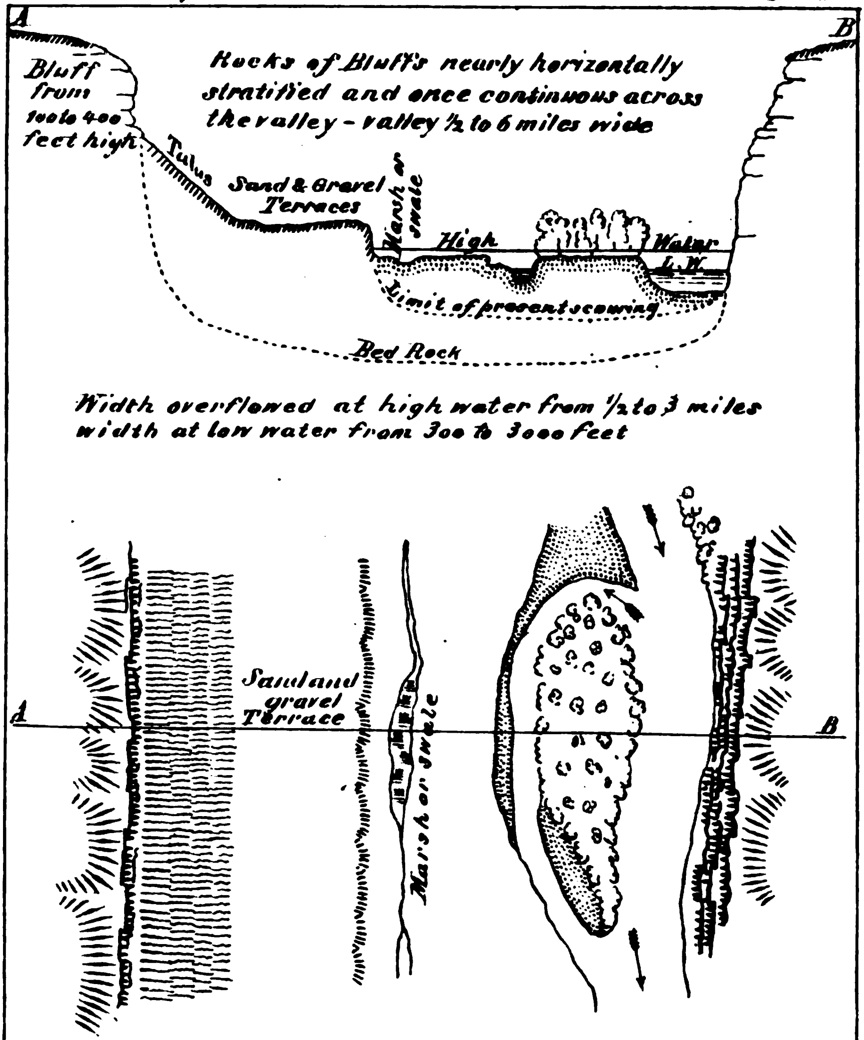
The fourth feature is the bed of the stream, which includes the part covered at medium stages, but large portions of which become dry sand or gravel bars at low stages.

There are thus four different prominent benches or levels in the river-valley:

1. The level forming the main bluff.
2. The sand-terrace, generally above overflow.
3. The bottom-land, generally overflowed at highest water.
4. The bed of the stream.

It is desirable that the topographical survey shall give the limits of each of these and their elevation. This may be in a very general way for all but the fourth level, to which the details of the survey should be mainly directed.

The sketch of the valley given above assumes a simple case where the river is divided by a single island, but the bottom-lands are often much more complicated in structure. There is generally, however, as in the case given, one main channel, and to this the more thorough work of sounding may generally be confined. Experience, good judg-



Generalized map & section
of a portion of
The Wisconsin River & Valley
illustrating instructions
for surveys in 1867-8-9
no definite scale

ment, and a knowledge of a special case, when it occurs, must govern the engineer as to what is to be done.

The survey will be conducted as follows:

A continuous transit-line will be carefully measured and staked off on one bank or the other of the main river, as may be most easy, and all the topography sketched along it. The opposite shore must be located by triangulation.

The topographical note-book must show both edges of the bottom-land, and the edge of the water at the time must fix the position of the stakes used by the sounding parties, and must locate all prominent buildings by measurements, angles, or bearings, when practicable.

When passing prominent points marks must be left, on which back-sights can be taken as the work progresses, and distant points on bluffs and buildings should be similarly used.

Accompanying this transit-line must be a careful line of levels, in which should be noted frequently the height of the bottom-lands or sand-terrace, when near, the height of the water of the river at the time, that of the last high water, and the most noted high or low water mark that may be ascertained. Both these instrumental surveys should establish marks, at least once a mile, on trees, rocks, or permanent buildings; carefully describe them in the notes, and select such as may be readily found after the lapse of years for future surveys to connect with, as well as for the detached portions of this survey.

There will be, besides this main line, two subordinate compass-parties to survey the minor channels, which will connect their work as often as possible with the main line, and must always do so at the point of beginning and ending of such subordinate line.

These parties will note, besides the topographical sketches and horizontal dimensions, the height of the banks, either bottom-land or sand-terrace, wherever they see them, and will make an occasional section by sounding across the slough or chute they are surveying.

In case one of these parties is surveying a channel as large, or nearly so, as the main channel, it must be sounded with the same care as the main channel, especially if there is any question about which one it would be most desirable to close up.

There will be a separate level-party to run level-lines transversely of the valley as often as the progress of the survey will permit, and where there are steep bluffs the hand-level can be used to level up to their summits.

In all cases side distances for locating important objects must be measured with a tape-line; pacing will frequently ascertain them with sufficient accuracy, and, if circumstances prevent this, the estimated distance must be noted.

The sketches must be made to a scale on the ground, must give the kind and quality of the trees, marshes, sand-bars, and rocks; and, when objects cannot be entered on the page by using the regular scale, the distance must be noted or estimated by angles or bearings from fixed points. Connections will be made as frequently as may be with the railroad line, and all the bridges and piers will be carefully measured and located, and notes made of all obstructions.

The sounding-lines will be run obliquely across the stream from 300 to 600 feet apart, more or less closely, as the correct understanding of the river-bed may require. The soundings will be taken with a pole at as nearly uniform intervals of time as practicable, with the boats rowed at uniform rates of speed, and practice must be acquired so that the same line can be sounded forth and back with approximately the same result. Occasionally it would be well to sound them both ways, especially at important points.

Where the grounding of the boat prevents the boat reaching the shore, the distance to the stake on the shore must be noted. The sounding-pole should be uniformly 12 or 15 feet long, and "no bottom" recorded where this will not reach.

The cadence of time is lost by changing one pole for another or for a sounding-line at deep places. These deep holes must be determined separately after the regular lines have been sounded. The engineer in charge of the sounding-party must keep a sketch of the river and lines sounded, and must locate, as far as he can with his eye, the position of the bars beneath the water.

At intervals of about 10 miles there should be two sections 200 feet apart carefully sounded, and a series of floats at middepth observed for velocities, so that the discharge can be accurately computed after the manner it is now being done at Saint Paul.

If possible, the main line should be kept plotted as the survey proceeds, on the scale of 200 feet to an inch, so that no confusion can occur in the system of lines kept in the note-books. A short time in the evening and times of bad weather will suffice for this. It will, besides, serve at once to show the directing engineer if the surveys made leave out any desired information. The quarter-boat is designed of ample size to furnish convenience for this work.

At the quarter-boat, whenever it is lying still, a gauge should be set up and the rise and fall of the river carefully noted. It will be of service, in connection with the reg-

ular river-gauges, in reducing the levels to a uniform state of the river during the time of the survey, so that the slope can be constructed for any stage observed.

In procuring subsistence for the parties, the quantities allowed per man will not exceed the allowance for a soldier in the armies of the United States. And the material procured will be limited to articles thus allowed, unless an equivalent of other materials can be obtained at an equal or less cost than these.

It is directed that no regular meal shall be served on the quarter-boat in the middle of the day, and arrangements must be made for sending a sufficiency of food from the boat to the place where the parties are at work. Small parties working at some distance from the boat must take this meal with them in the morning. In the evening a full dinner-meal will be served on the quarter-boat, and also in the morning before going to the work; and every exercise of authority must be used that this does not delay the commencement of the day's work.

The following party, besides the principal engineer, will be employed on this survey, but the engineer in charge is authorized to change the men from one party to another in any manner he thinks best, according to the nature of the work of each. For main transit-party, one engineer and six men; for main level-party, one engineer and three men; for cross-section level-party, one engineer and three men; for two compass-parties, each, one engineer and three men; for one sounding-party, one engineer and five men; cook and steward, two men; care of quarter-boat, two men.

The engineer in charge will endeavor to inform himself fully of the character and resources of the country for building dams of stone, timber, or brush, and for locks and other masonry. He must also keep a regular journal, detailing the operations of the different parties and other information. The survey will be conducted in the manner above described, from Portage to the mouth, and if, on arriving at the latter point, it should be found that additional surveys were required in special localities, as undoubtedly it will be, detached parties may be made to execute them.

A weekly report of progress will be made to this office, and further information given from time to time, if required.

G. K. WARREN, &c.

Some minor modifications only were made in conducting the survey. Instead of the edges of submerged bars being sketched in, the method was improved as far as practicable by fixing them by means of bearings to a level staff, with a telescope having a micrometer, by which the distance was obtained. The very complicated net-work of channels and wooded islands demanded so much work, that the boundaries of the bottom-lands next to the high bluffs and terraces could not all be determined in 1867, and such as were not were obtained in 1868–'69. It was impracticable to secure information complete enough to give more than an approximate idea of proper location for a canal, and to furnish a guide for a final survey for location.

The levels, though very carefully made, did not give the surface of the water as often as might be desired.

This slope was constantly varying, although for distances of 5 or 6 miles it is nearly uniform throughout. The assistant with the leveling-instrument, Mr. J. Z. Osborn, a gentleman much esteemed by all who knew him, was taken with a fever on the latter part of the survey, and died on the work. His place was filled by Assistant Wellman.

The hydraulic measurements were designed to get the volume of the water as nearly as possible by the method of Humphreys and Abbot, which was accepted without any attempt at verification on this survey. More careful hydraulic measurements were at the time being conducted at Saint Paul, under similar conditions of flowing water, and it was found there that, as far as anything could be inferred from observations in streams of this character, the laws obtained from the authors referred to were confirmed.

The original surveying-party was composed as follows:

Mr. E. T. Ellsworth, transit-party, on right bank.

Mr. E. L. Billings, compass-party, on left bank.

Mr. I. D. McKown, compass-party, on islands.

Mr. W. W. Rich, cross-sections of valley and location of sand-bar crests.

Mr. J. Z. Osborn, leveling-party.

Mr. R. J. Dukes, soundings and hydrography.

Bvt. Maj. Charles R. Suter was present, in charge. Mr. D. W. Wellman was general assistant, studying the subject and supplying temporary disability of any other assistant, or looking up any matter outside of their specialties. Mr. J. P. Cotton, who had acquired experience of my method of river-surveying during the autumn of 1866, assisted in setting the survey going at Portage.

The field-work was begun in August, and was completed down to the mouth on the 6th of November. A line of levels was also run above Portage to the Dalles at Kilbourn City.

The summary of field-work in 1867 is as follows:

	Miles.
Measured transit-line on river-bank	119.3
Measured compass-line on river-bank	117.1
Measured compass-line on islands	116.2
Measured cross-section lines of valley	53.0
Measured survey-lines near Portage and Prairie du Chien	10.0
Total measured lines	415.6
Measured main-line levelings	122.0
Approximate length of lines sounded over	375.0
Number of measurements of volume of Wisconsin	12
Number of measurements of volume of tributaries	5

This does not include the additions made in 1868 and 1869. In the above summary no mention is made of a multitude of triangulations, by which the surveys of opposite banks and at the head and foot of islands and bars were united.

DESCRIPTION OF THE MAPS AND DIAGRAMS MADE FROM THE SURVEYS.

An account of the labor of mapping this survey and the delays attending it has already been given in an introductory chapter, so we will proceed at once to enumerate the maps and diagrams.

Continuous plot scale, 200 feet to an inch.—The first plot has been constructed from the field-notes, on a scale of 200 feet to the inch, on white paper backed with cloth. This forms twenty-four sheets, with a uniform length of 10 feet each.

It has been the effort to put upon this map all the notes of the field-books, so that no further reference to them should ever be necessary. These sheets show the measured and triangulated lines, and thus indicate, by their proximity to objects represented, the accuracy which belongs to the representation. The appearance of the sand-bars as thus given was made with special care, and is intended to show this important feature as it was then presented. Although every part of this sandy bed changes from year to year, this representation will give a reliable idea of what it is in general—as much alike from year to year as are the leaves of a mature tree, although never exactly the same.

Improvements had accomplished nothing in changing them, and this map, therefore, shows these river sand-bars as seen by Marquette and Jolliet in 1673; by Major Long, United States Army, in 1817; by the Fifth United States Infantry in 1819, and by all subsequent examiners.

In the future study of them, by such as may desire, it must be kept in mind that these bars are all mutually related. A change in one affects

the flow of water (which caused the change), and this effect is felt above and below. The elevation of the river-surface, referred to an assumed datum-plane, and that of the deduced low-water surface are shown on these plots by figures inclosed by brackets.

Cross-sections of the valley—scale 400 feet horizontally and 40 feet vertically to the inch.—Besides this map—scale 200 feet to the inch—there are seventeen cross-sections of the valley on different sheets, made on a scale of 400 feet to the inch horizontally and 40 feet to the inch vertically.

Longitudinal profile of valley.—There was made a longitudinal profile of the river and the immediate banks where the line of levels was run, on scales of 2 inches to the mile horizontally and 1 inch to 40 feet vertically, and all the data that could be shown on a profile in regard to height of bottom-lands, terraces, &c., and slopes of water-surface and distances are given.

Plots of current-measurements for volume.—The measurements of sections and velocities of current, to obtain the volume of water passing, are plotted on manila paper, on scales of 100 feet to the inch horizontally and 20 feet to the inch vertically. On these plots are given the plotted courses of the current and all the calculations used in obtaining the volume. They are fastened together and properly designated, so that this important matter can be readily revised by any one.

All of the foregoing are suited to a study of special localities or subjects.

Map of river on a scale of 2 inches to the mile.—For the general consideration of the improvement a reduced map has been made on a scale of 2 inches to the mile, which is as small as will enable the important features to be shown. This scale was chosen because it is that of the United States land-survey township plots, as filed on their records. This map shows the main bluffs (which were often too distant to be included on the larger-scale maps), the terraces, bottom-lands, islands, dry bars, and under-water bars. The seventeen cross-sections of the valley are reduced and placed marginally along it, and the height of the water-surface is noted. This map is designed for publication with this report, if the report be published. It is divided into eight sheets for photolithographing.

General map of the route from Green Bay to the Mississippi River.—We have also prepared a general map and profile of the route from Green Bay to the Mississippi River. The map is on a scale of 6 miles to the inch, and shows the line of provisional location for a canal. The profile is on a scale of 8 miles to the inch horizontal and 40 feet to the inch vertical.

Sheet of river-gauge curves.—There have also been prepared for publication, in one sheet, diagrams on curves of rise and fall from the gauge-readings on Lake Winnebago, on the Wisconsin River, and on the Mississippi River, for the years 1867, 1868, 1869.

GENERAL DESCRIPTION OF THE BASIN OF THE WISCONSIN RIVER.

Form of basin, geographical position, &c.—The basin drained by this river is of a comparatively narrow, triangular form, bounded by the water-sheds between it and Lake Superior on the north, Lake Michigan on the southeast, and the Mississippi River on the southwest. From the source to Portage City the general course of the main river is south, the distance in a straight line being about 190 miles. Thence to its mouth the general course is west-southwest for a distance, in direct line,

of about 90 miles. The whole basin lies within the parallels of 43° and 46° 10′ north latitude and the meridians of 88° 45′ and 91° west from Greenwich, and covers about 11,850 square miles.

General elevation above the sea.—At the junction of the river with the Mississippi the surface at low water is about 625 feet above the level of the sea, which is about that of Lake Superior, Lake Michigan being 589 feet. The level of the country in this vicinity, at the top of the main high banks (or "bluffs" as they are generally called on western rivers), is from 400 to 500 feet higher, making the level of the high prairie-land or plateau from 1,000 to 1,100 feet above the sea. Ascending the river from the mouth to Portage the low-water river-surface rises 180 feet, making the low-water surface at Portage 805 feet above the sea. The high plateau rises nearly at the same rate, being just south of Portage about 400 feet above the river, or 1,500 feet above the sea-level. This high prairie is very much cut up by ravines and river-valleys, so that considerable areas are but little elevated above the surface of the river. The whole of the basin has been the scene of vast glacial denudation and deposition. At the sources the face of the country is characterized by lakes and swamps (a feature common to the sources of most of our northwestern rivers), and is elevated from about 1,400 to 1,600 feet above the sea, or from 100 to 300 feet above the highest lands near Portage. The water from the sources, therefore, descends from 600 to 800 feet in reaching Portage.

Geological formations in the basin.—The lake-region about the source is represented on Owen's* geological map as composed of heavy drift-deposits, 800 to 1,000 feet above the level of Lake Superior, underlaid with crystalline rocks, with occasional outcrops of granitic and igneous rocks. This is the character of the basin as far down as Whitney's Rapids, a distance from the sources in a straight line of about 130 miles. The width of the basin here does not exceed 60 miles. South of Whitney's Rapids the rocks of the Lower Silurian formation appear, generally showing an increased height above the river as it descends. The stratification is but little inclined, the general dip being to the southwest, with some few irregularities and reversals of dip.

From Whitney's Rapids to Honey Creek (34 miles below Portage), a distance by the river-valley of about 90 miles, the rock is generally a soft siliceous sandstone, easily crumbled. It has suffered great degradation, the *débris* supplying immense quantities of sand to recent terraces and river formations. The valley of the river from Whitney's Rapids to the Dalles is mainly a broad expanse of sand, with the sandstone rising out of it in detached hills. It is probable that this was formerly a lake-bed before the gorge at the Dalles was cut through, and that a waterfall formed the outlet of the lake, which cut away the barrier and drained the lake. The waves of such lake must have continued to abrade the sandstone and to spread the sand over the bed through which the Wisconsin now flows.

Below Honey Creek a magnesian limestone of the Lower Silurian begins to form the tops of the bluffs. As the stream descends the valley, the thickness of this limestone increases, and that of the underlying sandstone diminishes, the latter disappearing at the mouth of the river. This soft sand-rock, therefore, forms the bed-rock all the way down from Portage, and there can be but little doubt that under the influences to which it was subjected while the valley was forming, the excavation into

*Report of a Geological Survey, &c., by David Dale Owen, published by Lippincott, Grambo & Co., Philadelphia, 1852.

this bed was carried to a great depth. It is, at best, but the poorest of foundations for any structure like a dam, even if reached at a reasonable depth. The magnesian limestones furnish good building-material, remarkably easy to quarry and cut into shape.

In the basin there are no considerable formations of a geological age between the Silurian and the Post Pleiocene, but almost every variety of glacial drift, modified and unmodified, is found, and many terraces dating from the glacial period to the present time.

Climate of the basin.—The meteorological observations made by the Surgeon-General's Department United States Army* at Fort Winnebago, near Portage, and at Fort Crawford, on the Mississippi River, 3 miles above the Wisconsin, are the only ones in my possession in regard to the climate. The observations at Fort Winnebago and Fort Crawford were made at places "elevated 70 feet above the river." The elevations above the sea were at the first locality 870 feet, and at the second 695 feet. The river-valleys in which these observations were made are about 300 to 400 feet below the high lands in the neighborhood. The temperature-observations included the period from 1822 to 1845; those for measuring the rain-fall, from 1836 to 1845. The following are the average results obtained:

Table of mean temperature and rain-fall at Fort Winnebago and Fort Crawford, 1822–1845, *and* 1836–1845, *respectively.*

	Fort Winnebago.	Fort Crawford.
Mean spring-temperature	45°. 49 Fahrenheit	48°. 66 Fahrenheit.
Mean summer-temperature	67 . 96 Fahrenheit	72 . 28 Fahrenheit.
Mean autumn-temperature	45 . 96 Fahrenheit	48 . 34 Fahrenheit.
Mean winter-temperature	19 . 78 Fahrenheit	21 . 25 Fahrenheit.
Mean annual temperature	44 . 80 Fahrenheit	47 . 63 Fahrenheit.
Mean spring rain-fall	5. 58 inches	7. 63 inches.
Mean summer rain-fall	11. 46 inches	11. 87 inches.
Mean autumn rain-fall	7. 63 inches	7. 80 inches.
Mean winter rain-fall	2. 82 inches	4. 00 inches.
Mean annual rain-fall	27. 49 inches	31. 40 inches.

The subject is considered of sufficient importance to require these tables of monthly means to be given in full in this report, and they are accordingly copied below.

*Published as Senate Ex. Doc. No. 96, first session Thirty-fourth Congress, 703 pages, quarto, with an outline map, and entitled "Statistical report on the sickness and mortality in the Army of the United States, compiled from the records of the Surgeon-General's Office, embracing a period of sixteen years from January, 1839, to January, 1855. Prepared, under the direction of Bvt. Brig. Gen. Thomas Lawson, Surgeon-General United States Army, by Richard H. Coolidge, M. D., assistant surgeon United States Army, 1856."

Table of temperature at Fort Winnebago, Wisconsin.

Latitude, 43° 31′; longitude, 89° 28′; altitude, 870* feet.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Spring.	Summer.	Autumn.	Winter.	Year.
1829	25.49	9.64	33.77	46.83	64.01	68.40	70.08	70.36	61.11	53.45	31.00	33.75	48.90	69.61	49.19	22.96	47.49
1830†	17.43	28.20	38.40	57.35	61.97	71.38	83.65	76.20	67.83	60.21	47.62	27.21	52.57	77.08	57.22	22.96	52.46
1831	13.77	18.94	40.12	49.18	61.44	73.55	74.49	72.46	61.37	51.97	37.85	9.84	51.25	73.50	49.06	14.16	46.74
1832	24.40	16.52	41.58	53.52	57.40	72.75	76.04	71.38	64.95	55.69	37.02	32.63	50.83	73.39	52.55	24.52	50.32
1833	29.82	28.31	42.20	54.06	......	......	......	......	......	......	......	......	......	......	......	......	......
1834	......	......	......	......	......	......	......	......	59.73	47.35	39.00	22.51	......	......	......	......	......
1835	21.13	7.38	30.83	43.08	58.94	64.10	67.99	64.35	51.18	45.75	27.14	18.62	44.28	65.48	41.36	15.71	41.71
1836	15.95	17.66	20.49	40.34	56.65	62.06	67.56	61.67	54.33	36.75	31.25	16.98	39.16	63.76	40.78	13.53	39.31
1837	16.67	19.68	23.30	36.44	50.34	61.73	68.29	64.12	55.77	46.31	35.05	20.77	36.69	64.11	45.71	19.04	41.54
1838	17.95	6.04	37.89	37.50	49.35	66.57	73.01	68.22	56.49	39.21	21.63	12.93	41.58	69.27	39.11	12.31	40.57
1839	12.36	22.79	30.47	51.97	54.78	60.57	68.56	64.02	51.22	52.42	28.16	22.33	47.41	61.38	43.93	22.49	44.30
1840	12.78	22.97	31.52	44.76	58.95	63.38	66.52	64.49	54.45	43.82	30.00	16.45	45.08	65.46	42.76	17.40	42.67
1841	12.03	15.08	28.98	39.69	55.99	66.27	67.97	63.96	54.50	42.50	31.67	23.49	41.52	66.07	42.89	16.87	41.84
1842	20.52	21.95	39.70	50.58	52.88	57.66	66.16	65.39	57.63	47.89	26.76	18.31	47.72	63.10	44.09	20.26	43.79
1843	22.03	8.75	12.38	44.31	53.22	64.26	70.59	67.04	61.83	39.29	29.88	27.24	36.64	67.30	43.67	19.34	41.74
1844	16.57	24.47	35.02	55.17	......	63.21	71.10	66.43	59.10	43.69	32.11	20.87	......	66.91	44.93	20.64	......
1845	23.53	27.54	34.96	48.40	57.41	66.57	72.22	69.66	......	......	......	......	46.92	69.48	......	......	......
Mean, 16 years	19.52	18.50	32.60	47.20	56.66	65.63	70.95	67.31	57.83	47.90	32.14	21.33	45.49	67.96	45.96	19.78	44.80

* Changed from 770?—G. K. W.

† The summer-months of this year are reported as unprecedentedly hot and dry in Wisconsin.

Table of temperature at Fort Crawford, Wisconsin.

Latitude, 43° 5′; longitude, 91° 00′; altitude, 695* feet.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Spring.	Summer.	Autumn.	Winter.	Year.
1822	14.86	23.73	38.01	43.99	60.45	69.25	73.66	72.70	61.16	44.37	34.26	9.53	47.48	71.87	46.60	16.04	45.50
1824	24.59	20.14	26.96	43.86	58.46	67.90	71.34	70.12	61.84	46.53	41.86	26.56	43.09	69.79	46.74	23.76	45.84
1825	18.55	30.45	40.96														
1829							71.00	73.76	63.05	54.81	30.26	31.93			49.37		
1830	20.21	27.84	38.42	56.76	64.10	73.53	81.46	77.07	61.45	55.97	45.90	19.28	53.09	77.35	54.44	22.44	51.83
1831	9.22	18.90	36.80	47.26	61.90	72.69	76.56	71.93	60.17	52.00	29.54	5.97	48.65	73.73	47.24	11.60	45.30
1832	18.42	9.96	37.43	54.84	35.92	72.75	74.40	70.06	62.08	52.01	35.18	28.90	49.40	72.40	40.76	19.09	47.66
1833	27.57	23.94	34.85	58.86	64.92	70.49	78.72	76.57	70.27	43.79	39.47	32.66	52.88	75.26	51.18	28.06	51.84
1834	7.96	34.16	34.74	57.44	51.07	68.88	80.49	77.55	59.56	48.58	41.99	27.93	47.75	75.64	50.04	23.35	49.19
1835	26.27	9.47	35.74	46.45	64.57	68.77	73.83	70.25	56.45	49.57	29.74	21.69	48.92	70.95	45.25	19.14	46.06
1836	17.72	20.03	24.22	45.73	63.91	67.45	72.95	67.26	60.49	41.71	34.83	20.51	44.62	69.22	45.68	19.42	45.58
1837	18.43	25.84	26.86	42.56	56.71	64.08	73.74	70.97	61.14	50.06	39.66	21.57	42.02	69.60	50.29	21.95	45.96
1838	22.03	6.92	43.43	45.16	56.63	72.40	78.22	73.95	63.99	45.87	27.45	17.86	48.41	74.86	45.77	15.60	46.16
1839	27.38	28.88	35.65	61.56	63.44	69.51	78.71	72.05	58.81	59.53	33.55	25.49	53.55	73.42	50.63	27.25	51.46
1840	16.21	26.46	37.15	51.34	65.97	73.89	73.31	70.50	59.45	47.94	35.63	23.42	51.49	72.57	47.67	22.03	48.44
1841	16.79	21.78	36.92	44.99	64.78	71.43	74.25	69.16	59.49	47.61	36.87	25.82	48.90	71.61	48.99	21.46	47.74
1842	20.31	29.71	43.95	59.68	59.74	67.62	73.78	71.13	62.74	53.39	29.14	19.47	54.42	70.85	48.46	20.83	48.64
1843	20.17	7.70	8.29	45.60	56.22	67.16	74.00	71.10	65.18	40.22	31.27	28.61	36.70	70.75	45.56	18.83	42.96
1844	17.25	24.70	37.68	57.24	60.68	66.12	74.19	70.00	60.43	46.74	35.79	20.47	51.87	70.10	47.65	20.81	47.61
1845	21.43	28.06	38.27	52.57	61.01	68.07	75.25	72.33					50.62	71.88			
Mean, 19 years	19.43	21.67	34.53	51.88	60.58	69.55	75.26	72.03	61.54	48.92	34.56	22.65	48.66	72.28	48.34	21.25	47.63

*Changed from 642.—G. K. W.

Table of rain-fall at Fort Winnebago, Wisconsin.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Spring.	Summer.	Autumn.	Winter.	Year.
1836	......	......	......	......	......	......	......	0.16	4.53	0.77	1.28	1.77	......	......	6.87	......	......
1837	0.48	0.91	0.25	2.41	3.18	4.80	5.66	2.89	5.39	0.79	3.23	1.35	5.82	13.35	9.41	2.74	31.32
1838	2.03	0.20	0.08	2.98	0.86	2.40	7.67	5.35	2.64	1.49	1.77	0.41	3.92	15.42	5.90	2.64	27.88
1839	0.92	0.47	0.79	1.81	3.59	4.53	0.83	4.38	1.43	8.14	1.27	0.76	6.22	9.74	10.84	2.15	28.95
1840	0.80	1.17	0.48	1.46	2.03	3.71	5.79	3.47	1.45	4.03	2.68	0.05	3.97	12.97	8.16	2.02	28.12
1841	0.18	0.43	1.54	1.49	1.51	5.45	3.70	3.79	6.58	1.25	0.53	1.98	4.54	12.94	8.38	2.59	28.43
1842	0.84	0.56	1.71	1.85	1.17	5.04	3.24	2.14	3.45	0.21	3.12	1.18	4.73	10.42	6.78	2.58	24.51
1843	0.72	0.62	0.39	2.14	4.18	4.07	1.20	1.22	4.41	0.60	2.67	0.58	6.71	64.43	7.68	1.92	22.80
1844	1.51	0.58	1.33	3.52	......	4.07	5.40	5.16	2.73	0.73	1.56	1.75	......	14.63	5.02	3.84	......
1845	0.67	2.49	3.10	2.67	1.46	4.09	4.37	1.53	......	......	......	......	7.33	0.99	......	......	......
Mean	0.91	0.82	1.07	2.26	2.25	4.24	4.21	3.01	3.62	2.00	2.01	1.09	5.58	11.46	7.63	2.82	27.49

Table of rain-fall at Fort Crawford, Wisconsin.

1836	......	......	......	......	3.60	1.10	3.20	2.30	6.40	1.30	0.50	1.60	......	6.60	8.20	......	......
1837	0.40	2.70	2.90	3.00	1.40	4.40	1.83	3.65	7.18	1.16	2.51	2.92	7.30	9.88	10.85	6.02	34.05
1838	1.30	0.00	0.45	3.57	1.03	2.17	1.58	5.68	2.76	1.66	1.44	0.32	5.05	9.43	5.86	1.62	21.96
1839	1.72	......	1.26	2.07	0.54	5.10	1.57	6.30	4.95	5.05	1.90	1.00	3.87	12.97	11.90	......	31.46
1840	1.40	1.00	0.20	3.62	2.75	2.57	2.97	6.91	1.90	5.85	1.96	0.12	6.57	12.45	9.71	2.52	31.25
1841	0.19	0.47	5.76	2.04	1.75	2.36	7.75	3.65	2.45	1.21	0.14	3.28	9.55	13.79	3.80	3.94	31.05
1842	1.29	1.13	2.00	4.08	6.20	7.08	1.00	6.43	3.58	0.08	3.47	2.03	12.28	14.51	7.13	4.42	38.34
1843	0.70	0.93	0.58	1.60	2.82	3.10	2.20	4.13	4.90	1.33	2.82	0.47	5.00	9.43	9.05	2.10	25.58
1844	2.60	0.87	1.42	3.56	4.71	4.01	8.81	6.06	2.46	0.76	1.42	2.38	9.69	18.88	4.64	5.85	39.06
1845	1.10	2.79	2.73	3.36	2.40	5.50	3.90	1.35	......	......	......	......	8.49	10.75	......	......	......
Mean	1.19	1.24	1.92	2.99	2.72	3.74	3.48	4.05	4.06	2.04	1.80	1.57	7.63	11.87	7.90	4.00	31.40

From these tables it will be seen that the annual rain-fall is some years 20 per cent. below the average and occasionally as much as 25 per cent.

The summer-rains, on the average, are earlier by two months at Portage than at the mouth of the river, and somewhat heavier, although the annual average is a little the greater at the mouth.

We have no series of observations of the rain-fall in the upper part of the basin, but as far as we can infer from our river-gauge observations in 1867, '68, and '69, the region seems not so well supplied with summer-rains as the adjoining basins east and west of it. The upper part of the basin lies in the belt of coniferous trees—pine, spruce, hemlock, and larch—and there is a large business done in making lumber from them. The lower portion of the basin is partly open prairie, partly covered by forests of trees common to this latitude: oak, chestnut, beech, birch, maple, elm, cottonwood, willow, cedar, &c. Where the soil is not too sandy, wheat, barley, oats, maize, hops, &c., grow well, so that, although the climate is comparatively dry, artificial irrigation is not needed

DESCRIPTION OF FEATURES OF THE VALLEY OF THE WISCONSIN.

Definition of term "valley," &c.—By the valley is meant that portion of the basin inclosed within the visible outline of the high banks as seen from the river. On this river the high banks are mainly composed of stratified rocks, but in some instances of high terraces of drift-material. It will be sufficient for the purposes of this report to limit our attention to the portion of the valley from the Dalles, 20 miles above Portage, to the mouth. The Dalles are a narrow gorge formed by a cut through the sandstone rock about 5 miles in length, and in the narrowest place only 54 feet wide. The effect of this contraction is such as to restrain the floods, so that they are said sometimes to rise 50 feet above low water in the valley above, while the same flood will rise not to exceed 10 feet in the valley below. The valley attains its greatest width in the neighborhood of Portage, where it varies from 6 to 12 miles. Here the Fox and Wisconsin Valleys are the same, not being separated by any high ground. The valley becomes narrower at Dekorra, 8 miles below Portage, not there exceeding a width of 3 miles. The river washes directly against the sandstone at Dekorra, where this rock does not rise higher than about 60 feet above the water-surface, while the more distant bluffs on the other side rise about 400 feet above the water. From Dekorra down to the mouth, the valley varies in width from 1 to 6 miles. The course of the outline of the main bluffs and the valley between them is very direct below Portage. The central line of the valley plotted from near the mouth of Baraboo River runs about S. 47° W. for 20 miles; then S. 15° W. for 8½ miles; then N. 89° W. for 39 miles; S. 47° W. for 10 miles; then S. 71° W. for 10 miles; then S. 49° W. for 7 miles; and then W. for 5 miles to the junction with the Mississippi. The total distance by these courses is 99½ miles. The distance in a straight line between the junction of the Baraboo with the Wisconsin and the junction of the Wisconsin with the Mississippi is about 90 miles and the course about S. 67° W. The windings of the main valley, therefore, only increase the direct distance by about 10 per cent.

Slopes and terraces not overflowed at high water.—A large portion of the part included as valley is made up of the foot-slopes of the high banks, which, by the addition of glacial and alluvial deposits, became terraces above the present high-water level of the river, and were not formed by it under existing conditions. The terraces are quite a feature of the valley. Some are composed of modified glacial drift, some of

river gravel, and some of fine sand. The river, sometimes, in its course, washes directly against these terraces, which thus continually contribute to the material in the river-bed. At other times broad strips of bottom-lands, only submerged at high water, separate the river from the terraces. These terraces are not continuous along the valley, but in detached parts. The larger of these are usually, in their natural state, prairies covered with grass and oak-openings. One of them is Sauk Prairie, lying upon the right bank, on which Sauk City stands. It is 3 to 5 miles wide and 10 miles long. This is one of the most valuable agricultural tracts in the Wisconsin Valley. Such places may furnish good canal-location. Ten miles below this, on the left bank, is another such terrace, about 20 feet above the river, 2 or 3 miles in width, and 6 or 8 miles in length. Two miles farther down, Spring Green Prairie begins, on the right bank, elevated 30 to 40 feet above the river, 3 miles wide and 10 miles long. About 3 miles below, on the left bank, is the English Prairie, 1 to 3 miles wide and 14 miles long. Five or six miles lower down, on the left bank, is another, 2 miles wide and 6 or 7 miles long, on which is the site of Boscobel. There are many other terraces, generally at a higher level above the river, composed of coarser materials than sand and usually wooded.

Marginal lands and islands overflowed at high water.—All along the river, with but few exceptions, is a strip of low land, commonly called bottom-land, from 3 to 6 or 8 feet above low water. These lands are generally highest next to the river, and slope away from it, often terminating in lakes or marshes. Where it is not occupied by lakes, marshes, or sloughs, it is covered by a dense forest of trees and undergrowth. The wooded islands are of the same origin and nature as the bottom-lands, and in many instances they are scarcely to be distinguished or separated; in others they divide the river into several distinct channels, being sometimes as much as 3 miles long. There is a great number of these channels and islands, the shore-lines of which more than double that which a single channel would have. The width of the flood-plain, that is, the width from one edge of the overflowed lands to the opposite edge, including river and islands, below the Baraboo River, is from three-quarters of a mile to 3 miles. The course of the flood-plain is nearly that of the valley, and, as given before, is 99½ miles from the Baraboo River to the Mississippi. The distance by the course of the main river between the same points is 113 miles, so that the increase of length, by the windings of the river, over that of the flood-plain to which it is confined is less than 15 per cent. This directness of flow is a peculiarity of clear-water streams with sandy beds and high slopes. In muddy streams with low slopes it is not an uncommon thing for the meanderings of the river to be double the length of the flood-plain. There seems to be a relation between these two cases pointing to a common cause and effect. The banks of the muddy stream, having more firmness, cause the river to scour the bed and preserve a single channel, while the gradual yielding of the concave bends increases the curvature and folds, and thus establishes resistance by increased surface of friction, and by diminishing the slope as the course lengthens. In the case of the sandy stream, the banks yield more readily than the bed, and thus the stream spreads and islands form on dry sand-bars, dividing the river into separate parts. This increases the frictional surface and diminishes the velocity until a limit is reached. One accommodates its bed to slope and volume by lengthening, the other by widening. The water of the Wisconsin is very free from sediment, and at ordinary times quite clear, with a tinge of amber color from decaying vegetation.

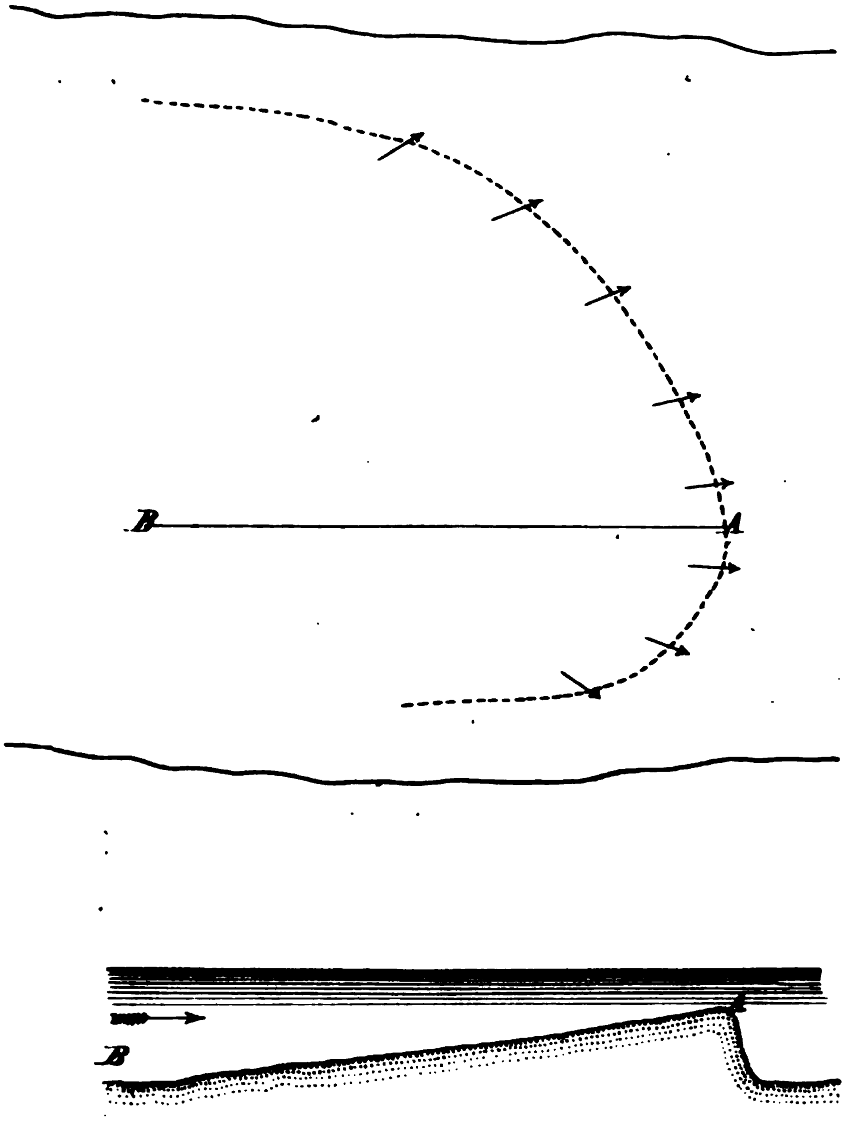
THE RIVER-BED.

Sand-bars.—In the ordinary practical point of view, these form the most important feature of our subject as regards direct effect upon navigation. They were noted by the first explorers in their canoes, and no one treating of the river since has failed to give them prominence. Between Portage and the mouth of the river these shoals are numbered by hundreds. They are composed of grains of almost pure siliceous sand.

Formation of sand-bars.—The sand is moved down stream on or near the bottom. Part of it is deposited in slack or still water where this occurs along the shores, while the greater part is dropped in the still water on the down-stream edge of the bars, in both cases to be again taken up at some future time, under the varying conditions, and moved still farther down.

The most important bars are those which are formed by accessions at their lower edges. This kind of bar forms most rapidly where the current is the strongest, and thus the lower edge, which is the shoalest part, is convex down stream, the most advanced part being where the main thread of the stream is flowing. The sand is moved along the gentle slope of the upper side till the crest is reached, when it falls over and stops in the still water below. As the bar thus grows down stream it becomes more convex, and the water alters its course gradually, so as to pass the crest nearly in the direction of the normal lines. The effect of the extension is, therefore, to widen the overflow over the crest (which acts as a weir) and the bar becomes more shoal as it advances, as shown in Figs. 1 and 2, Plate 3; the dotted line represents the crest of the bar, and the arrow-heads indicate the direction of the current over it.

The upper surface of the bar slopes toward the water-surface down stream, in a few cases that we measured, at a rate of 0.6 of a foot in a hundred. How far this action would go on in an unchanging condition of the river is not ascertainable, for a rise or fall changes the conditions, gives new courses to the current, and allows the formation of new bars occupying positions different from those of previous ones, but all having the same general law of growth. They are thus superposed on one another at different stages. Some of them have a depth of water just below the crest of 10 feet or more, and others of only a few inches. Where one bar thus forms over a previous one, they frequently do not cohere along their lines of junction, and the weight of a man in case of a small bar, or of a descending vessel in case of a larger one, a little way above the crest, is often sufficient to move the upper bar bodily down stream; these bars can thus be passed with considerably more water by a descending than by an ascending boat. When a bar moves down to near a small island, the current is checked so that no more sand passes over the crest. It therefore does not close onto the island unless at flood-stages, when the current passes over the island. The bar, however, often continues to form down the channel on each side of the island. It should be stated, too, that the crest of the moving bar, for the same reason, does not unite with the shore on either side, but leaves a narrow deep place between the bar and the shore, forming what is known as a "pocket" on account of the inability of getting out of the upper end. This upper end of the pocket is closed with a flat sand-shoal, such as forms on the sides of the shores from the material which the current leaves behind in the slack water, due to the retardation by friction along the banks, or in the still water at the lower ends of islands or points. There is a whole class of bars which forms in this latter way



Form of Sand bars
Wisconsin River
Horizontal scale 200 ft = 1 inch
Vertical " 10 " "

in slack water along the shores. The effect of these is to narrow the river as it declines to low stages, the action being similar to that of a wing-dam. The moving sand-bars, by spreading and shoaling the water, are the ones that cause the greatest difficulty to navigation.

Action of sand-bars at low water.—All sand-bars have the effect of retarding the flow of the water, and thus producing short stretches of deeper water above them. This effect is well known to the raftsmen, who are warned by finding an unusually good pool at one place that they must meet with a proportionally bad series of bars below. Considering the large slope of the Wisconsin, it may be that this sandy bed is, on the whole, a benefit to natural navigation, such as rafting, by preventing a more rapid flow of the water; this more rapid flow would take place if the river could free itself from sand, and we would probably have a stream composed of pools and shallow rock-rapids. In the extreme low-water stages of the Wisconsin, bars will be very frequently met whose crests cannot be passed with anything drawing more than 15 to 18 inches. There are persons who say that when the river begins to rise the crests of the bars rise with the water-surface, so that there will be no more draught of water over them when the river shall have risen a foot or more along the shore. Although there may be some cases which appear to confirm such statement, I do not think it can be generally true, even if experience does show that every foot of rise in the stream is not realized in an equal increase of depth over the crests of the bars.

In very low stages of long continuance the bars formed at high water become dry; the stream cuts out narrower channels among them, withdrawing itself into a narrower compass, and materially lengthening the water-course while proportionately decreasing its slope. All this tends to improve navigation as long as the low stage lasts, but a rise, by changing the direction of the water, sends it across the low-water channels and fills them up, so that the rise itself, if small and temporary, is regarded as an injury on all the sandy-bed rivers of the Upper Mississippi basin.

Very bad sand-bars in the Mississippi below the Wisconsin.—The sand moving down the Wisconsin and falling into the Mississippi causes the worst of shoals to be formed in the latter stream for several miles below the junction. At the confluence of these two rivers the Wisconsin bars protrude into the Mississippi, narrowing it and forcing its channel across to the high banks of its right or west shore, and acting as a dam. A very considerable diminution of the slope of the Mississippi above is thus produced, and the river is, for many miles, comparatively deep, flowing quietly and lake-like, with excellent channels for navigation. These benefits are obtained at the cost of very bad navigation for many miles below. The Wisconsin sands, moved down by the Mississippi water, form massive bars or shoals, similar in every respect to those on the Wisconsin, over which the water flows with increased velocity and slope. This effect, as just noted in the Mississippi above and below its junction with the Wisconsin, is common to all streams in this region where they receive a tributary, viz, good navigation above this point and bad below. One of the most noted instances of this is the deep Lake Pepin, in the Mississippi above the mouth of the Chippeway River (a stream the exact counterpart of the Wisconsin), and the extremely bad shoals extending for miles below.

Very bad sand-bars in the Wisconsin at the junction.—The bars that form in the mouth of the Wisconsin are also very shoal. This river comes from a region of much less summer-rain than the Mississippi. The latter, therefore, has rains and floods when the other has not. The

Wisconsin is often at low stage when the Mississippi is high, and the waters of the former are thus backed up for several miles above its mouth. Special deposits, at such times, take place in the Wisconsin, which its own water is unequal to clearing away when the Mississippi falls again. It is something of a similar feature to this that occurs in the Cumberland at its junction with the Ohio, and which has led to the extensive works of amelioration which have been resorted to there.

Movement of sand-bars down stream.—The movement of the sand-bars down the Wisconsin and the Mississippi is well established. We have observed it in both, sometimes as it progressed, and sometimes afterward by the survey of the same bar in different years. This motion is slow. We have noted it as much as 800 feet a year, but it was only the slowly-moving bars that we could then measure. Generally the same bar cannot be recognized the second year. This is easily understood. Each bar expresses a certain relation between resistances and moving forces. Though this be maintained through considerable changes of volume, it nevertheless will soon happen that the bar will pass into a portion of the river wider, or deeper, or of changing curvature, beyond which its individuality will be lost. This individuality, however, has enough vitality and persistence to cause the forces producing it to repair any artificial change rapidly, and thus to render the operations of dredging or scraping very unsatisfactory.

Sources and quality of the sand.—This sand, disregarding the inequalities of the bars, is spread with much general uniformity over the bed of the Wisconsin, and constitutes the principal ingredient of the bottom-lands and islands. It is derived from sand-terraces along its banks, belonging to a former condition of the valley. It originated largely from the breaking up of the sandy rocks of the Silurian formation, through which this river mainly flows, during the glacial period. Its repeated handlings and movings by water have made this sand very clean, and it contains nothing but silex except a little admixture of iron and black magnetite iron-sand. These iron ingredients undergo further oxidation on exposure, and tinge the sand generally of a yellow hue, so that terraces formed of it are frequently named "yellow banks." The accumulation of this iron oxide is sometimes sufficient to partially cement the material together, so that it may be broken, presenting the appearance of a crumbling sandstone. As found in the river, this sand is easily moved by waves and currents, and presents the very worst of foundations for any engineering constructions. The presence of the heavy black magnetite sands which are not easily moved, and which are found so difficult of separation from gold-dust in placer-mining, shows that the power which is exerted in moving these sands is considerable, otherwise it would have left this heavy sand behind.

Comparison of Wisconsin sand with other water-moved sands.—The sand of the Wisconsin has been frequently spoken of as easily moved. So far as this is true I think it is due to the force of the water on such a heavy slope, and not to any special nature of the sand. In order to set this matter at rest, I procured sand from several localities on the Wisconsin and the Mississippi and from other places, and had a comparison made of them, as shown in the following tables:

Table of the sizes of sands from different locations.

Location.	Would not pass a sieve 20 mesh to 1 inch.	Passed 20 sieve; would not pass 40.	Passed 40 sieve; would not pass 60.	Passed 60.	Total.	Magnetite, per cent.	Remarks.
Portage, Wis	.0278	.4277	.4313	.1130	.9998	.0005	Wisconsin River.
Spring Green, Wis	.0400	.3371	.5004	.1220	.9995	Inapp.	
Saint Paul, Minn	.2143	.6561	.1073	.0219	.9996	.0049	Mississippi River.
Nininger, Minn	.2920	.5823	.1185	.0074	1.0002	.004	
Beef Slough, Wis	.0814	.5598	.2989	.0596	.9994	.0021	
Fountain City, Wis	.0558	.3798	.4341	.1302	.9999	.004	
Rock Island, Ill	.0068	.1101	.4723	.4104	.9996	.0004	
Saybrook Bar, Conn	.0383	.5470	.3600	.0514	.9967	Inapp.	Long Island Sound, mouth of Connecticut River.
Block Island, R. I	.0204	.6218	.2673	.0302	.9997	....	Ocean beach.
Newport, R. I	.0000	.0553	.5948	.3499	1.0000	Inapp.	Do.

Table of the changes in volume in different sands due to wetting when loose and when packed.

Location.	Loose sand, shrinkage.	Packed sand, shrinkage.	Packed sand, expansion.	Remarks.
Portage, Wis	.0146	....	.0113	The sand was packed by submitting each half-inch layer in a gill measure to the pressure equivalent to one half an atmosphere, for 20 minutes.
Spring Green, Wis	.0197	.0042	....	
Saint Paul, Minn	.0695	....	.0262	
Nininger, Minn	.0432	....	.0160	
Beef Slough, Wis	.0563	....	.0044	
Fountain City, Wis	.0350	.0150	....	
Rock Island, Ill	.0296	.0000	.0000	
Saybrook Bar, Conn	....	....	....	
Block Island, R. I	.0788	....	.0381	
Newport, R. I	.1352	....	.0459	

Table of specific gravities of sands from different locations.

Location.	Unsifted sand, loose, including voids.	Unsifted sand, packed, including voids.	Unsifted sand, loose, excluding voids.	20 mesh, coarse, loose, excluding voids.	20 fine, 40 coarse, loose, excluding voids.	40 fine, 60 coarse, loose, excluding voids.	60 fine, loose, excluding voids.	Weight of cubic foot, loose and dry.
								Pounds.
Portage, Wis	1.5786	1.7333	2.6392	2.5861	2.6256	2.6392	2.6670	98.66
Spring Green, Wis	1.6376	1.7471	2.6667	2.6391	2.6597	2.6806	2.6806	102.35
Saint Paul, Minn	1.5923	1.7240	2.6397	2.6583	2.6381	2.6378	2.6258	99.51
Nininger, Minn	1.6504	1.7480	3.6184	2.6095	2.6200	2.6220	2.6316	103.15
Beef Slough, Wis	1.5716	1.7080	2.6348	2.6493	2.6427	2.6286	2.6556	98.22
Fountain City, Wis	1.6690	1.6860	2.6400	2.6480	2.6408	2.6396	2.6420	104.31
Rock Island, Ill	1.5579	1.7364	2.6166	2.5946	2.6259	2.6122	2.6259	97.36
Saybrook Bar, Conn*	1.5407	....	2.6406	....	....	....	....	96.29
Block Island, R. I	1.4650	1.6860	3.6392	2.6431	2.6392	2.6256	2.6448	91.56
Newport, R. I	1.3895	1.5547	2.6563	....	2.6500	2.6563	2.6660	86.84

* Quantity too small to make all the determinations. The sand in every case was dry.

Gravel and bowlders in river-bed.—In a few cases the bed of the river, where it flows next to gravelly banks, is composed of compact gravel. This is notably the case for a mile or more below Sauk City, and here the river shows the most contracted channel found on the survey. At other places, as just below Dekorra, the gravel forms a broad, shoal bar.

It is probable that works of contraction that will cause the movement of the sands will develop considerably more gravel-deposits than are now visible. Along the bluffs at Merrimac and at some other places bowlders are now seen, and many others would probably be found in deepening the channel.

Falling trees and snags.—All along the Wisconsin River the erosion of the bottom-lands at the concave bends undermines the trees and causes them to fall, sometimes into the river and sometimes shoreward. In the latter case the roots often afford protection to the banks against further erosion; in the former, they finally wash out and sometimes stop in the channel, forming snags. In very narrow places these inclining trees form serious obstructions to the navigation of boats and occasionally to that of rafts. Scarcely a year passes without some of these trees being cut or dragged away by the river-men, and once or twice there has been a considerable public expenditure made in this way. (See Chapter III.) I employed a party on this work between Portage and Sauk City in 1869. The removal of these snags with the banks in their natural state is but a temporary remedy, as other trees are continually falling into the stream. As an obstruction, however, they are a matter quite insignificant compared with the shoals.

Bed-rock.—Rock in place is found at a few points in the bed of the river. In the vicinity of Dekorra the sandstone which crops out on the left bank forms the river-bed for some distance from the shore. At Muscoda sandstone appears in the bed of the river near the left bank, and 4 or 5 miles above this same rock forms the bottom for a distance of from one-half to three-fourths of a mile.

The piles for the piers of the Muscoda bridge were driven to the rock, which was found at a depth of 20 to 30 feet from the surface of the water. No examination was made at the time of the survey to ascertain the thickness of the sand overlying the rock in the bed of the river. This rock is generally sandstone, easily broken up, and there are many reasons for believing it to have been deeply abraded in former times. Even when reached it would generally furnish a very poor foundation to resist the overflow from any dam constructed in the river-bed.

BRIDGES.

Below Portage City there were at the time of the survey, in 1867, four wagon and three railroad bridges over the Wisconsin.

The first is a wagon-bridge at Prairie du Sac; it is a rickety old structure and needs rebuilding. It has two spans, of about 100 feet each, of lattice-truss, combined with a rough arch, and a draw with two openings of 42½ feet each in the clear. The remainder of the bridge is made up of eighteen spans of trussed girder, each from 45 to 60 feet in length; total length of bridge, 1,237 feet. The main spans stand on timber cribs, once filled with stone, with a foundation of piling. The other spans rest upon trestle-work.

The second bridge is at Sauk City. This is a wagon-bridge similar to that at Prairie du Sac, though more recently built and in a more substantial manner. There are five spans of lattice-truss from 120 to 123 feet each in length. The draw has two openings, each 47 feet wide in the clear. The remainder of the bridge is made up of shorter spans of trussed girder.

The third wagon-bridge is at Muscoda. The superstructure of this bridge is first class. The main bridge consists of two spans, on the Howe-truss plan, 150 feet in length each, and of the draw, which has two open-

ings of 56 feet each. One end of the draw rests upon the sand-rock on the left bank. The remainder of the bridge rests on pile trestle-work, and extends to the terrace on the right bank. The total length of the bridge is 1,683 feet; the piers are cribs of square timber, nicely framed together and filled with stone, resting upon a foundation of piling protected by riprap. The pile trestle-work above mentioned is filled with riprap up to low-water mark, so that at that time most of the water is thrown through the three spans near the left bank, giving at all times probably 5 or 6 feet of water under the draw.

The fourth wagon-bridge is at Bridgeport. It has two lattice-truss spans, each 160 feet in length, and a draw with one end resting on the right bank. Only one opening of the draw-span—54½ feet in the clear—is available for navigation. The remainder of the bridge is on trestle-work.

The three railroad-bridges are similar in their construction, all being built on the Howe-truss plan, with spans of about 100 feet in length.

The upper bridge has eight spans besides the draw. The total length of the bridge, including trestle-work, is 1,930 feet. The draw-piers make an angle of 64° with the axis of the bridge. The draw-openings, on the line of the bridge, are 53.6 feet and 56.8 feet wide, respectively, and on a line perpendicular to the piers about 47 and 50 feet.

The middle bridge has seven spans besides the draw. The draw-piers of this bridge make an angle of 60° with the axis of the bridge.

The clear span in each opening, measured on the axis of the bridge, is about 54 feet, and about 50 feet on a line at right angles with the piers.

The lower railroad-bridge has two spans of 125 feet each, one of 95 feet, and the draw in the principal channel, and four spans of 100 feet each over the other channel. These two channels are about one-half a mile apart. The draw-piers of this bridge are perpendicular to the axis of the bridge, with openings of 54.6 feet on the right hand and 55.6 feet on the left.

The piers of the railroad-bridges and of the wagon-bridge at Bridgeport are of stone, resting upon a foundation of piling filled with and protected by riprap. So much riprap has been used in protecting the piers that the steamboat-channel has been contracted to less than 30 feet at low stages, practically filling it up and throwing the main part of the river through other portions of the bridge.

The draws of these bridges are badly located, in most cases being placed near the middle of the river instead of near one shore, where the channel could be directed by artificial means at a much less expense than in the middle of the stream.

Table of widths of draw-openings in the bridges on the Wisconsin River.

Location.	Width at low-water line.		Width at top of piers.		Top of piers above low water.
	Left opening.	Right opening.	Left opening.	Right opening.	
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Prairie du Sac bridge	42.5	42.5	42.5	42.5	....
Sauk City bridge	47.0	47.0	47.0	47.0	....
Upper railroad-bridge	(*)	(*)	53.6	56.8	12.0
Middle railroad-bridge	(*)	(*)	54.5	54.0	12.1
Muscoda bridge	....	56.0	(†)	56.0	....
Lower railroad-bridge	(*)	(*)	55.6	54.6	10.1
Bridgeport bridge	....	No water.	54.5	No water.	....

* Batter of piers unknown.

† End of draw on shore.

Observations at the gauges at Portage and at upper and middle railroad-bridges were begun in August, 1867, and, when not interrupted by ice, were continued at those places during 1868, and excepting at Portage, during 1869. (See diagrams accompanying this report.) The zero is one-half a foot below the low water of 1867. The following tables are summarized from these observations:

Table showing the duration of different stages of water in the Wisconsin River at Portage.

Year.	Depth 0—1 foot.	Depth 1 to 2 feet.	Depth 2 to 3 feet.	Depth 3 to 4 feet.	Depth 4 to 5 feet.	Depth 5 to 6 feet.	Depth 6 to 7 feet.	Depth 7 to 8 feet.	Remarks.
	Days.	*Days.*	*Days.*	*Days.*	*Days.*	*Days.*	*Days.*	*Days.*	
1867	93	58	30	26	19	7	......	......	River closed December 9, 1867; opened April 12, 1868; closed December 1, 1868.
1868	104	46	33	36	2	......	......	......	
1869	......	......	......	......	......	......	......	......	

Table showing the duration of different stages of water in the Wisconsin River at upper railroad-bridge, begun August 1, 1867.

Year.	Depth 0—1 foot.	Depth 1 to 2 feet.	Depth 2 to 3 feet.	Depth 3 to 4 feet.	Depth 4 to 5 feet.	Depth 5 to 6 feet.	Depth 6 to 7 feet.	Depth 7 to 8 feet.	Remarks.
	Days.	*Days.*	*Days.*	*Days.*	*Days.*	*Days.*	*Days.*	*Days.*	
1867	36	83	3	......	......	......	......	......	River closed December 1, 1867; opened March 28, closed December 3, 1868; opened April 1, closed December 1, 1869.
1868	2	122	36	19	24	25	17	1	
1869	......	19	28	77	51	41	26	2	

Table showing the duration of different stages of water in the Wisconsin River at lower railroad-bridge, begun August 3, 1867.

Year.	Depth 0—1 foot.	Depth 1 to 2 feet.	Depth 2 to 3 feet.	Depth 3 to 4 feet.	Depth 4 to 5 feet.	Depth 5 to 6 feet.	Depth 6 to 7 feet.	Depth 7 to 8 feet.	Remarks.
	Days.	*Days.*	*Days.*	*Days.*	*Days.*	*Days.*	*Days.*	*Days.*	
1867	38	82	3	......	......	......	......	......	River closed December 3, 1867; opened April 1, closed December 2, 1868; opened March 28, closed December 4, 1869.
1868	74	79	21	18	44	10	4	......	
1869	......	35	65	67	45	22	18	......	

The years 1867 and 1868 were each marked by three rises in the river. These occurred in 1867, on April 20, June 7, and September 28; in 1868, on April 3, June 21, and November 6. These changes of level are common to all the northwestern rivers. The first rise is known as the "ice freshet," and lasts but a few days, usually. The second is known as the "June rise," and upon it the lumbermen chiefly rely to get their logs down the tributaries into the main streams, where they can be rafted. This rise usually occurs in the early part of June, simultaneously with the breaking up of the ice in the lakes and the melting of the snows at the headwaters, and with rains; it sometimes does not come until much later, and occasionally there is a season when there is no rise at this time. The next usual rise is in the beginning of autumn, from the 20th of September to the middle of October; sometimes, however, it does not occur until near the close of the season.

The year 1869 seems to have been an unusual one on the Wisconsin, from its continued high water. The usual ice-freshet came in the early

part of April, and was followed by another high water of longer duration on the 28th of April. From this time the river continued to fall until the 15th of June, when it commenced to rise again, and continued to rise until the 30th of the month, when it was between 6 and 7 feet. This was followed by frequent rises, so that the river fell but once below 3 feet on the gauge. From the end of September the river continued to fall until the middle of November, when there was a small rise of a few days' duration.

SLOPE OF WATER-SURFACE.

Our leveling did not touch upon the river-surface oftener than at intervals of 700 to 1,500 feet; the slopes thus obtained vary from 0.095 feet to 3.696 feet per mile. While the survey was in progress, the river rose and fell within the limit of $1\frac{1}{10}$ feet above the low water of 1867, for which changes a correction was made in the levels taken, so as to get the approximate low-water slope for that year. In getting the slope, the distances, as measured along the main surveyed line, were taken, which may not in all cases correspond with the distance along which the water flowed; the latter could not be well determined, and as there were no deductions based on these slopes, no attempt has been made to correct for this difference in distance as given in the succeeding table. The irregularities of slope, as shown by this table, convey but a feeble idea of the ever-varying low-water slope corresponding to the irregularities of the bed. In some places the sudden pitch, as at the crests of bars, was visible to the eye, and at others, where a high local velocity from a steep slope was taken up in a pool, the slopes would be found reversed.

In the same section at right angles to the general course the water was found moving in different directions, each part having a slope of its own. The general average throughout the river, when taken for distances of 5 or 6 miles, is very uniformly about $1\frac{1}{2}$ feet to the mile, corresponding to the uniformly sandy bed.

The high-water slopes were obtained from the high-water marks of the flood of 1866, the highest known for many years. This slope is very nearly the same as the average low-water slope, and this may therefore be taken as the average slope for all stages.

Table of measured low-water slopes in the Wisconsin River.

Distance.	Fall.	Fall per mile.	Total fall.	Total distance.	Distance.	Fall.	Fall per mile.	Total fall.	Total distance.
Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
1, 500	. 561	1. 97	. 561	1, 500	5, 500	2. 567	2. 46	83. 889	280, 300
2, 800	. 967	1. 82	1. 528	4, 300	4, 000	1. 023	1. 35	84. 462	284, 300
2, 000	. 036	. 095	1. 564	6, 300	4, 300	. 921	1. 14	85. 383	288, 000
900	. 052	. 31	1. 616	7, 200	6, 200	2. 143	1. 82	87. 526	294, 200
1, 400	. 274	1. 03	1. 890	8, 600	4, 200	1. 688	2. 12	89. 214	298, 400
2, 000	. 855	2. 26	2. 745	10, 600	6, 600	2. 152	1. 72	91. 366	305, 000
1, 300	. 556	2. 26	3. 301	11, 900	5, 000	1. 454	1. 53	92. 820	310, 000
3, 000	1. 195	2. 10	4. 496	14, 900	4, 700	1. 608	1. 80	94. 428	314, 700
1, 600	. 394	1. 22	4. 890	16, 500	6, 100	2. 004	1. 73	96. 432	320, 800
1, 300	. 177	. 72	5. 067	17, 800	5, 800	1. 303	1. 18	97. 735	326, 600
1, 400	. 345	1. 30	5. 412	19, 200	4, 700	1. 354	1. 52	99. 089	331, 300
2, 900	. 938	1. 71	6. 350	22, 100	7, 700	1. 426	. 98	100. 515	339, 000
1, 100	. 173	. 83	6. 523	23, 200	1, 500	. 395	1. 39	100. 910	340, 500
2, 800	. 897	1. 69	7. 420	26, 000	3, 700	1. 010	1. 44	101. 920	344, 200
1, 800	. 623	1. 80	8. 043	27, 800	7, 200	2. 828	2. 07	104. 748	351, 400
1, 600	. 647	2. 13	8. 690	29, 400	4, 100	1. 420	1. 83	106. 168	355, 500
2, 300	. 780	1. 79	9. 470	31, 700	5, 800	1. 591	1. 45	107. 759	361, 300
3, 200	1. 303	2. 15	10. 773	34, 900	5, 000	1. 326	1. 40	109. 085	366, 300
7, 200	1. 989	1. 46	12. 762	42, 100	14, 300	3. 795	1. 40	112. 880	380, 600
1, 900	. 813	2. 26	13. 575	44, 000	4, 400	1. 595	1. 91	114. 475	385, 000
1, 300	. 678	2. 75	14. 253	45, 300	2, 600	. 987	2. 00	115. 462	387, 600
3, 400	. 935	1. 45	15. 188	48, 700	5, 400	1. 269	1. 24	116. 731	393, 000
5, 600	1. 024	. 96	16. 212	54, 300	6, 300	1. 240	1. 04	117. 971	399, 300
700	. 490	3. 696	16. 702	55, 000	5, 900	1. 667	1. 49	119. 638	405, 200
4, 000	. 696	. 92	17. 398	59, 000	6, 200	1. 441	1. 23	121. 079	411, 400
2, 400	. 552	1. 21	17. 950	61, 400	6, 400	1. 736	1. 43	122. 835	417, 800
6, 000	3. 053	2. 53	21. 003	67, 700	3, 500	. 904	1. 36	123. 739	421, 300
5, 300	. 975	. 97	21. 973	73, 000	4, 100	1. 299	1. 67	125. 038	425, 400
1, 500	. 207	. 73	22. 184	74, 500	3, 400	. 644	1. 00	125. 682	428, 800
2, 600	. 935	1. 90	23. 119	77, 100	14, 700	3. 836	1. 38	129. 518	443, 500
5, 200	1. 913	1. 94	25. 032	82, 300	10, 800	2. 951	1. 44	132. 479	454, 300
1, 600	. 210	. 69	25. 242	83, 900	11, 900	3. 314	1. 47	135. 783	466, 200
3, 800	. 840	1. 17	26. 082	87, 700	8, 800	2. 312	1. 39	138. 155	475, 000
3, 000	. 845	1. 48	26. 927	90, 700	3, 400	. 710	1. 10	138. 805	478, 400
2, 900	. 609	1. 11	27. 536	93, 600	6, 900	1. 834	1. 40	140. 639	485, 300
4, 400	1. 607	1. 93	29. 143	98, 000	5, 466	1. 743	1. 68	142. 382	490, 766
3, 850	1. 064	1. 46	30. 207	101, 850	10, 600	2. 766	1. 38	145. 148	501, 366
5, 050	2. 085	2. 18	32. 292	106, 900	5, 100	1. 383	1. 43	146. 531	506, 466
3, 200	. 842	1. 39	33. 134	110, 100	3, 700	. 700	. 99	147. 231	510, 166
2, 300	. 781	1. 79	33. 915	112, 400	2, 700	. 476	. 93	147. 707	512, 866
4, 400	1. 419	1. 70	35. 334	116, 800	4, 800	1. 816	2. 00	149. 523	517, 666
6, 200	1. 494	1. 27	36. 828	123, 000	2, 800	. 879	1. 66	150. 402	520, 466
3, 000	. 635	1. 11	37. 463	126, 000	1, 100	. 093	. 446	150. 500	521, 566
4, 000	1. 006	1. 33	38. 469	130, 000	3, 500	. 841	1. 27	151. 341	525, 066
2, 200	. 450	1. 08	38. 919	132, 200	2, 100	. 621	1. 56	151. 962	527, 166
3, 100	. 919	1. 56	39. 838	135, 300	2, 700	. 651	1. 27	152. 613	529, 866
4, 000	1. 016	1. 34	40. 854	139, 300	2, 100	. 322	. 81	152. 935	531, 966
1, 700	1. 047	3. 25	41. 901	141, 000	4, 300	1. 016	1. 25	153. 951	536, 266
8, 100	1. 851	1. 20	43. 752	149, 100	2, 900	. 623	1. 13	154. 574	539, 166
2, 950	. 618	1. 11	44. 370	152, 050	2, 600	. 471	. 95	155. 045	541, 766
6, 850	2. 596	2. 00	46. 966	158, 900	2, 500	. 694	1. 46	155. 739	544, 266
6, 100	2. 166	1. 87	49. 132	165, 000	2, 700	. 602	1. 14	156. 341	546, 966
7, 600	2. 290	1. 59	51. 422	172, 600	2, 700	. 598	1. 17	156. 939	549, 666
7, 100	1. 756	1. 30	53. 178	179, 700	2, 650	. 392	. 78	157. 331	552, 316
4, 000	1. 302	1. 72	54. 480	183, 700	2, 550	. 757	1. 41	158. 088	554, 866
5, 700	1. 737	1. 61	56. 217	189, 400	4, 600	1. 168	1. 34	159. 254	559, 466
5, 700	1. 722	1. 59	57. 939	195, 100	2, 600	. 656	1. 33	159. 910	562, 066
4, 900	1. 271	1. 37	59. 210	200, 000	2, 700	1. 195	2. 34	161. 105	564, 766
1, 500	. 443	1. 56	59. 653	201, 500	3, 000	. 571	1. 00	161. 676	567, 766
5, 400	. 927	. 906	60. 580	206, 900	2, 600	. 810	1. 62	162. 486	570, 366
5, 300	2. 177	2. 17	62. 757	212, 200	3, 100	1. 029	1. 75	163. 315	573, 466
2, 000	. 313	. 826	63. 070	214, 200	1, 800	. 130	. 38	163. 445	575, 266
4, 900	1. 829	1. 97	64. 899	219, 100	4, 900	. 868	. 93	164. 313	580, 166
11, 700	3. 871	1. 75	68. 670	230, 800	5, 700	1. 461	1. 35	165. 774	585, 866
4, 700	1. 597	1. 79	70. 267	235, 500	5, 200	1. 597	1. 60	167. 371	591, 066
10, 900	2. 686	1. 30	72. 953	246, 400	6, 300	1. 518	1. 27	168. 889	597, 366
4, 200	1. 218	1. 53	74. 081	250, 600	6, 200	2. 122	1. 81	171. 011	603, 566
4, 100	1. 313	1. 69	75. 394	254, 700	2, 300	. 868	1. 99	171. 879	605, 866
6, 600	1. 877	1. 50	77. 271	261, 300	6, 800	1. 562	1. 21	173. 441	612, 666
3, 000	1. 069	1. 88	78. 340	264, 300	6, 000	2. 442	2. 15	175. 883	618, 666
5, 600	1. 700	1. 60	80. 040	269, 900	3, 900	. 858	1. 16	176. 741	622, 566
4, 900	1. 272	1. 37	81. 312	274, 800	800	. 448	2. 95	177. 189	623, 366

BEND EFFECT.

For the purpose of ascertaining something of the effect of the bends upon the river between Portage and the mouth, we employed Dubuat's

formula with the Humphreys and Abbot numerical coefficient ("Physics and Hydraulics, p. 315"), $h_{,,} = \frac{v^2 \sin^2 d}{134}$. To get the $\sin^2 d$, a curved line was drawn on the 24 large sheets along the course of deepest water, and tangents were drawn to this, making angles varying from 40° to 15° with each other, as follows: 97 of the tangents thus drawn made angles of 40°, 37 made 35°, 364 made 30°, 124 made 25°, 133 made 20°, and 6 made 15°. The total amount of deflections from the straight lines as thus measured amounted to 21,945°; or an equivalent of 60 complete circles. From this data we obtained $h = v^2 + 1.353$. If we take $v = 1.75$ feet per second, which is as near as we can approximate to the mean low-water velocity, we have $h = 4$ feet. This shows that, as far as we are able to measure the bend effect, the fall of the river's surface from Portage City to the mouth would only be 4 feet less with the same mean velocity if the river were straight. The length of this curved line along which the curvature was measured was about 124.7 miles. The total fall is 178 feet. Subtracting the bend effect from the total fall, we shall have the average slope along this curved line 1.395 feet per mile. If it were practicable, by rectification of the river, to give the low-water channel this development and curvature, we might adopt this slope as the one for the improvement; but it will be seen when we come specially to consider this matter that we shall be unable to make the new low-water channel vary much from the high-water one. The length of the high-water channel from Portage City to the mouth is 115.8 miles.

The curvature is much less at high water, as is shown by the diminished distance (nearly 8 miles), but we did not specially measure it, as its effect is at most so small.

From what has been said before, in speaking of the limiting bluffs and course of the valley, it will be readily perceived that the course of the river at high water, if rectified, cannot be materially increased in length over what it now is. We are, therefore, within limits when we take the average length of the river at 118 miles, which we do in all our calculations. There is no practical point that I know of in the consideration of the subject that is not independent of any error that might be thus made in a limit so narrow.

VOLUME OF DISCHARGE.

Method of measuring volumes.—The method of gauging the stream was as follows: The float used was a paint-keg about 9 inches high, which was suspended at mid-depth whenever the depth was great enough to admit it. At places the river was so shoal that this small float occupied a very considerable portion of the depth. In computing the discharge given in our tables, we have regarded this measured velocity as the mean velocity of the vertical longitudinal section or prism through which the float moved. The volume from this determination may be from 3 to 5 per cent. too great, but the correction to be applied is uncertain, and there were other sources of irregularity which rendered a very precise determination of volume impossible, although near enough for any practical purposes. The places selected for gauging were such as gave the stream in a single channel, or nearly so, and nearly free from sand-bars. These places are rare at low stages of the river, and only twelve were found suitable during the whole survey. At such places the conditions were all very exceptional.

Table of measured and low-water volumes.—The following table contains the actual measurements made of the volumes of the Wisconsin and its

tributaries at and below Portage City, with columns showing the areas drained and the low-water volume adopted for 1867:

[The minus sign after gauge-reading signifies that the river was falling; no sign, that it was on a stand.]

Wisconsin River and tributaries.	Distance from Portage, miles.	Date.	Nearest gauge-reading.	Measured volume, cubic feet per second.	Area drained, square miles.	Total area drained, square miles.	Adopted low-water volume.
Wisconsin River at Portage – Above canal	0	Aug. 24	0.6 —	3,360	8,200	8,200	2,800
Wisconsin River at Portage – Below canal	0	Aug. 24	0.6 —	3,152	8,200	8,200	......
Do	2	Aug. 29	0.55—	3,679	....	8,200	......
Duck Creek	3	....	0.5 —	....	100	8,300	......
Baraboo River	5	Aug. 31	0.5	431	675	8,975	......
Rocky Run	7	....	0.5	....	25	9,000	......
Wisconsin River at Dekorra	8	Sept. 2	0.5	3,558	....	9,010	3,175
Merrimac Creek	17	....	0.5	....	20	9,030	......
Ockee Creek	18	....	0.5	....	130	9,160	......
Creek at Skinner's	21	....	0.5	....	20	[illegible]180	......
Wisconsin River – At Skinner's Bluff	22	Sept. 10	0.5	3,275	....	9,180	3,275
Wisconsin River – At Sauk City	29	Sept. 17	0.5	....	....	9,200	......
Creek at Yellow Banks	32	....	....	....	15	9,215	......
Honey Creek	34	....	....	....	185	9,400	......
Three-Mile Creek	38	....	....	....	10	9,410	......
Black Earth Creek	41	....	....	....	190	9,600	......
Mill Creek	51	....	....	....	120	9,720	......
Dodge Valley Creek	52	....	....	....	35	9,755	......
Wisconsin River at Lone Rock	54	Oct. 2	1.6	6,557	....	9,820	......
Rush Creek	58	....	....	....	40	9,860	......
Otter Creek	59	....	....	....	120	9,980	......
Wisconsin River at Middle Railroad Bridge	61	Oct. 4	1.4 —	5,942	....	10,080	3,660
Bear Creek	63	....	....	....	80	10,160	......
Pine River	66	Oct. 8	1.2 —	241	270	10,430	......
Eagle River	73	....	....	....	100	10,530	......
Port Andrew Creek	79	....	....	....	15	10,545	......
Wisconsin River at Port Andrew	79	Oct. 18	1.4	5,944	....	10,555	......
Blue River	82	Oct. 19	1.4	220	190	10,745	......
Knapp's Creek	88	Oct. 23	1.4	70	100	10,845	......
Wisconsin River near Boscobel	89	Oct. 23	1.4	6,568	....	10,865	4,170
Trout Creek	90	....	....	....	20	10,885	......
Saunders's Creek	91	....	....	....	20	10,905	......
Boyd's Creek	95	....	....	....	10	10,915	......
Green River	98	....	....	....	70	10,985	......
Kickapoo River	100	Oct. 29	1.4	700	730	11,715	......
Wisconsin River near Wauzeka	102	Oct. 30	1.4	8,111	....	11,775	4,750
Warner's Creek	106	....	....	....	20	11,795	......
Grand Gris Creek	107	....	....	....	25	11,820	......
Bridgeport Creek	111	....	....	....	20	11,840	......
Wisconsin River – At Bridgeport	112	Nov. 4	1.2 —	6,977	....	11,850	4,790
Wisconsin River – At mouth	118	....	....	....	....	....	......

Explanation of the construction of the table.—Special importance attaches to the low-water volume in considering the method of improving the natural channel of the river. This importance is greatest at Portage City, where the volume is less than elsewhere in the portion whose improvement is to be considered. Near this place several measurements were made, which serve as a check upon each other. On the 24th of August a measurement was made above and below the guard-lock of the Portage Canal, into which there was probably flowing at that time 150 cubic feet a second, which amount, added to the volume as measured below, makes a very near agreement with that obtained above. A third measurement, made five days afterward, a little lower down, seems to be from 300 to 500 feet too large when compared with the others. There was a slight rise in the river about this time. The next measurement made was at Dekorra, 8 miles below Portage, after the river had fallen $\frac{1}{10}$ of a foot. It gave the volume 3,558 cubic feet per second. In this intervening distance the Baraboo River, Duck Creek, and Rocky Run had somewhat swelled the volume to the amount probably of 500 cubic

feet per second. This amount, taken from the Dekorra measurement, makes it a little less than that measured just below the guard-lock at Portage; such should be the case, as the river had fallen a little at the gauge at Portage. We cannot make any close comparison, for the amount drawn off by the canal was variable, and its influence at Dekorra could not be exactly measured.

The next measurement was at Skinner's Bluff, at which time the river was at the lowest stage reached in 1867; there the volume was 3,275 cubic feet per second. The small streams coming in between this place and Dekorra drain 140 square miles, and may have brought in about 50 cubic feet per second, which we will allow, to compensate for the diminished volume of the Baraboo since it was measured. Taking the low-water volume of all tributaries between Skinner's Bluff and Portage at 500 cubic feet per second, and deducting this amount from the lowest water-volume measured at the first-named place, would give us, as the lowest water-volume at Portage, 2,775 cubic feet per second.

This would accord well with our measurement at Portage, by allowing that a fall of two-tenths of a foot diminished the discharge at that point from 250 to 300 cubic feet per second.

We have, therefore, adopted in the table 2,800 cubic feet as the low-water volume of 1867 at Portage. This is as far down the river as we can regard the measured results as checking each other. The volume at Sauk City would seem to indicate even a less volume than above adopted, but at that place, unfortunately, our result was impaired by neglecting a small chute whose capacity was not determined.

The low-water volumes increase as we descend, showing that the additions more than compensate for evaporation, and, consequently, if there is a sufficient amount at Portage there will be enough lower down the river. Still, it is desirable to ascertain the low-water volumes throughout, so that we may dispose of the consideration of the question, which may arise, whether, if necessary to continue the canal below Portage, we may not reach a point where the river-volume will admit of its being suitably improved for navigation.

During the progress of the survey below Sauk City the river had begun to rise somewhat, and continued fluctuating, so that the volume measured was greater than the low-water volume. The application of river formulæ to deducting the volumes of discharge is but a rough approximation, in so shallow a stream, with such variable local slopes and obstructed sandy bed. This is specially the case near low water, when a slight rise or fall greatly changes the width and area of the section. Our slope-measurements are generally over considerable distances. The river is one in which the conditions of uniform motion are entirely absent. The only course was to take the Chezy formula $v = B \sqrt{rs}$ in its general form, and, by applying it to all places where our measured volumes were taken, deduce local values for B. This, when done, we assume will enable us to get an approximate result for a rise or fall not exceeding one foot from the stage at which the volume was measured.

The values of B thus obtained are given in the following table. The sectional area used is the mean area of the sections within the space for which the slope was measured.

Locality.	Above low water.	Mean of measurement.						B.
		Volume per sec.	Area.	Wet. per.	r.	v.	Mean slope.	
	Feet.	*Cubic feet.*						
Portage	0.2	3,256	1,861	724	2.432	1.749	.0003484	61
Dekorra	0.1	3,539	2,288	697	3.283	1.547	.000229	56
Skinner's Bluff	0.0	3,275	2,105	1,160	1.808	1.691	.000285	60
Upper Railroad Bridge	1.1	6,557	2,014	364	5.655	3.185	.000287	79
Middle Railroad Bridge	0.9	5,942	2,911	798	3.648	2.041	.000254	68
Port Andrew	0.9	5,944	2,701	647	4.174	2.201	.000273	65
Boscobel	0.9	6,568	3,328	972	3.424	1.973	.000275	64
Bridgeport	0.7	6,977	4,158	1,094	3.797	1.698	.000205	61
								64½

With these values of *B* at the different localities we deduce the low-water volume at the Middle Railroad Bridge and at Bridgeport. The manner of calculating was as follows: For these small changes of stage the slope was regarded as constant, the wetted perimeter and width the same, and the change in area of section was obtained by multiplying the width by the amount of rise and fall, and adding the product to or subtracting it from the mean sectional area as measured. This method neglects the small amount of decrease and increase of sectional area which results from a decrease or increase in the width, but this was small in amount and not to be obtained with accuracy, and would but little affect the result.

Thus, to find a low-water volume at the Middle Railroad Bridge we multiply 798 by $0.9 = 718.2$, and subtract this amount from 2,911, obtaining 2,192 square feet as our low-water new area of section. The new value of r is $3.648 - 0.9 = 2.748$. Substituting these quantities in the formula

$$v = 68 \sqrt{2.748 \times 0.000254} = 1.796,$$

hence volume will be

$$2{,}192 \times 1.796 = 3{,}938 \text{ cubic feet per second.}$$

A similar application of the formula to the case at Bridgeport gives us the low-water volume for 1867 5,200 cubic feet per second. Both of these low-water volumes appear too large to be in harmony with the low-water volumes actually measured higher up the river, when considering that the low-water volumes must, in a measure, be proportional to the area drained. We have, therefore, reduced these amounts about 8 per cent.

Volumes at a stage 1 *foot above the low water of* 1867.—For the last five places named in the preceding table for values of *B* the Wisconsin was measured when near the stage 1 foot above low water of 1867.

Applying the Chezy formula with the new constants in the same manner we did when deducing low-water volume, we obtain the volume for the stage 1 foot above low water, as shown in the first column of the next table.

Locality.	Calculated volume per second, in cubic feet.	Cubic ft. per second per square mile drained.	Adopted result.
Upper Railroad Bridge	6,233	.634	6,170
Middle Railroad Bridge	6,275	.622	6,280
Port Andrew	6,142	.582	6,630
Boscobel	6,824	.628	6,825
Bridgeport	8,032	.677	7,435
Mean	....	.628	....

Not feeling sufficient confidence in applying the Chezy formula to get the volumes at the stage one foot above low water to the places above the Upper Railroad Bridge, we have preferred to get it by taking the measured quantity at the Upper Railroad Bridge, and diminished it above in proportion to the diminished area of drainage.

Table of volumes at low water and at a stage one foot above.

Locality.	Distance from Portage, in miles.	Area drained, in sq. miles.	Low-water volume, 1867.	Volume 1 foot above.
Portage	0	8, 200	2, 800	4, 950
Dekorra	8	9, 010	3, 175	5, 440
Skinner's Bluff	22	9, 180	3, 275	5, 530
Sauk	29	9, 200	3, 275	5, 530
Upper Railroad Bridge	54	9, 820	3, 575	6, 170
Middle Railroad Bridge	61	10, 080	3, 660	6, 280
Port Andrew	79	10, 555	3, 980	6, 630
Boscobel	89	10, 865	4, 170	6, 825
Wauzeka	102	11, 775	4, 750	7, 360
Bridgeport	112	11, 850	4, 790	7, 435

Volumes at Skinner's Bluff for all stages.—For obtaining these volumes we make use of the Humphreys-Abbot formula for mean velocity. (Equation 40, page 312, Physics and Hydraulics of the Mississippi.) Knowing by measurement the volume at low water of 1867 at this place, the area of section, hydraulic mean depth and width, we take the Humphreys-Abbot formula for the value of *s* (equation 36, page 312), and deduce the slope which would produce this low-water discharge through this known section. It is 0.000067420.

Our next step is one of some uncertainty, as we have no other measured volume to deduce the corresponding value of *s* at this point, which we have selected because we have the sectional area pretty well determined for all stages, which is not the case elsewhere. This natural section being a contracted one for medium and high stages, it is probable that the value of *s* (which for the low-water discharge is but little more than one-fourth of the average slope) quite rapidly approaches the average as the river rises, and may exceed it in highest stages. We have, however, assumed that the slope in the river at this place reaches the average at a stage 4 feet above low water, and thereafter remains constant up to the highest flood, 10 feet above low water. Between the low water and the stage 4 feet above we have assumed that the value of *s* increases uniformly with each foot of rise. With these values of *s* and the known dimensions of the section, we deduce the value of *v*; which, multiplied by the corresponding sectional area, gives the volume. The volume thus determined for the stage 1 foot above low water is about 170 cubic feet per second less than what we previously obtained by proportioning the volume at the Upper Railroad Bridge to the diminished drainage-area at Skinner's Bluff. These determinations of volume, however, have but little practical value in the future discussion of river-improvement, being only used in considering the plan of reservoirs at the sources. We have taken the low-water volume as that actually measured at Portage, and the high-water volume is not so important, as we have taken the new high-water channel to be at least equal in dimensions to this natural one; and if this will not accommodate the river, the current will increase the sectional area by deepening. We have used these

volumes, in discussing improvement by reservoirs at the source, to determine what reservoir-capacity it would be necessary to provide to maintain the natural river at different stages above low water. It is well to remark here that it is highly probable that the low water of 1867 was not an extreme one, and that in such years as 1864 the extreme low-water volume is not greater than 1,500 cubic feet per second at Portage.

Table of volume at Skinner's Bluff for all stages of the river.

Stage of water.	Width.	Area.	Hydraulic mean depth.	*v.*	Volume.	*s.*
Low water	1,160	2,104	1,808	1.556	3,275	.000067420
1 foot above	1,162	3,265	2,798	1.695	5,530	.000121815
2 feet above	1,164	4,427	3,785	2.1544	9,540	.000176210
3 feet above	1,166	5,589	4,766	2.680	14,980	.000230605
4 feet above	1,168	6,751	5,744	3.110	21,060	.000285
5 feet above	1,170	7,913	6,708	3.387	26,800	.000285
6 feet above	1,172	9,075	7,684	3.625	32,900	.000285
7 feet above	1,174	10,237	8,648	3.849	39,400	.000285
8 feet above	1,176	11,399	9,607	4.062	46,300	.000285
9 feet above	1,178	12,561	10,561	4.259	53,500	.000285
10 feet above	1,180	13,723	11,510	4.460	61,200	.000285

ANOMALOUS PHYSICAL FEATURES OF THE WISCONSIN AND FOX RIVER BASIN.

The near approach of the streams without uniting.—The example presented by these two streams in their near approach at Portage, thence flowing in opposite directions—forming a channel of communication between distant waters—is one of the most remarkable to be found in the West, although not standing quite alone. It is this feature which gives to the route its most apparent advantage, and that has led to its use and improvement. In regard to its relations to physical geography it is also interesting, for an attempt to account for the relations of present conditions cannot fail to give us a clearer general idea of the structure of the country.

Peculiarities in the course of the Wisconsin.—This stream approaches Portage from the northwest, and turning to the right, bends through an angle of 130°, and pursues a course a little south of west to the Mississippi. After passing Portage it enters a valley between nearly horizontaly-stratified rocks, once as high at least as 500 feet above the present stream, and continuous across its course. The present river could not have eroded this course while the valley of the Fox was open, and this deep valley must date back to some former time, probaly preceding the glacial period. Along the valley below Portage the terraces indicate a much higher level of the water than at present, as is the case in most of the northwestern valleys.

Peculiarities in the course of the Upper Fox.—This river approaches Portage from the northeast, and then, turning to the right, doubles back and pursues a northeast course to Lake Winnebago. There is a general absence of high banks in proximity to its course, although low alluvial terraces are common. It winds through broad savannas, with gentle slope and sluggish current, occasionally passing into lakes. Three of these lakes—Mud Lake, Buffalo Lake, and Lake Puckaway—are caused by the deposits of affluents which the main stream has not been able to wash away, indicating plainly that the present Upper Fox did not erode its course, for it has not even the power to keep itself free, and is filling up. Lake Buttes des Morts and Lake Winnebago are depressions which the present tendency is to fill up. The same is true of Lake Poygun,

through which the Wolf River passes before joining with the Upper Fox.

Lower Fox River.—This is simply an outlet of Lake Winnebago, whose surface is about 170 feet above Lake Michigan.

The waters descend with great rapidity over beds of limestone rock, forming numerous rapids. The valley is here narrow and gorge-like, and the sides are not to exceed 50 feet in elevation above the stream at the head of the Grand Chute.

Analogies between Lake Winnebago Basin and the Lake Winnipeg Basin in British America.—The Upper Fox River, like the Red River of the North, is separated by but low intervening grounds from a stream flowing in an opposite direction, with which there is an interchange of waters in floods. They both have a northerly course. The valleys of these two rivers are alike in being broad and undefined, and the banks but little elevated above the lakes into which they flow.

Both lakes have northeastern outlets, and these outlets are obstructed by rocks, and have rapids and falls. Both lakes have low shores and shallow water on their west sides, and high shores and deep water on their east sides.

Probable former extent of Lake Winnebago.—The low, level alluvial terrace bordering the west side of Lake Winnebago has a very considerable extent. I asked Capt. W. S. Edwards, chief engineer of the Green Bay and Mississippi Canal Company, to get for me the outline of the high ground bordering it, which he did. It is presented on the accompanying diagram, Plate IV, the outline shaded by horizontal ruling.

If this alluvial deposit was made in an ancient lake, this diagram gives an approximate outline of it.

Hypotheses consistent with above-noted conditions.—We have only to suppose that all the waters of Lake Winnebago Basin (including that of the Upper Fox) formerly drained to the Wisconsin River; that a slow change of level in this region elevated the southwestern part and depressed the northeastern part till a large lake was formed, which finally overflowed, forming the course of the Lower Fox. This explains the present doubling back in the course of the Upper Fox and tributaries, and it accounts for the close relation and yet opposite courses of the Fox and Wisconsin Rivers. As the level changed, the erosion at the outlet could not keep pace with it, and so prevent a lake forming, because a granite ridge lies near the surface, between the Wisconsin and Buffalo Lake. When the Lower Fox outlet formed, the loose material covering the rocks rapidly gave way, and lowered the lake-level down to the rock, which now keeps it at its present level. The period of this change I regard as post-glacial, because this alluvial terrace is free from glacial drift; which it could not have been if formed before in a region like this, surrounded with glacial-drift deposit.

A similar change in the course of the Red River of the North is treated of by me in my report on the Minnesota River. (See Annual Report of Chief of Engineers, United States Army, for 1875.) There the case of the Fox and Wisconsin Rivers, along with some others, is referred to; all regarded as indicating a relative elevation at the south and depression at the north, which has affected the continent.

Previous attempts at generalization in regard to the Fox River.—The only previous attempt at generalization of natural features along the Fox River, that I know of, was made by Mr. John B. Pettival, civil engineer, in report dated January, 1838, Doc. No. 102, H. of R., War Department, Twenty-fifth Congress, third session. He says, "That the succession of different valleys from Fort Winnebago (near Portage) to Grand

Chute (Lower Fox River) was filled with water, making a chain of lakes. The barrier of the Grand Chute being thrown open by some convulsion of nature, the more shallow lakes were drained, and the deeper remained sheets of water, and the river a meandering drain.' He does not seem to have perceived the effect of such tributaries as the Montello River in causing some of these lakes, but his generalization, like mine, involves an idea of the recent formation of the outlet by the Lower Fox.

PROBABLE CHANGE IN THE DRAINAGE OF THE FOUR LAKES NEAR MADISON.

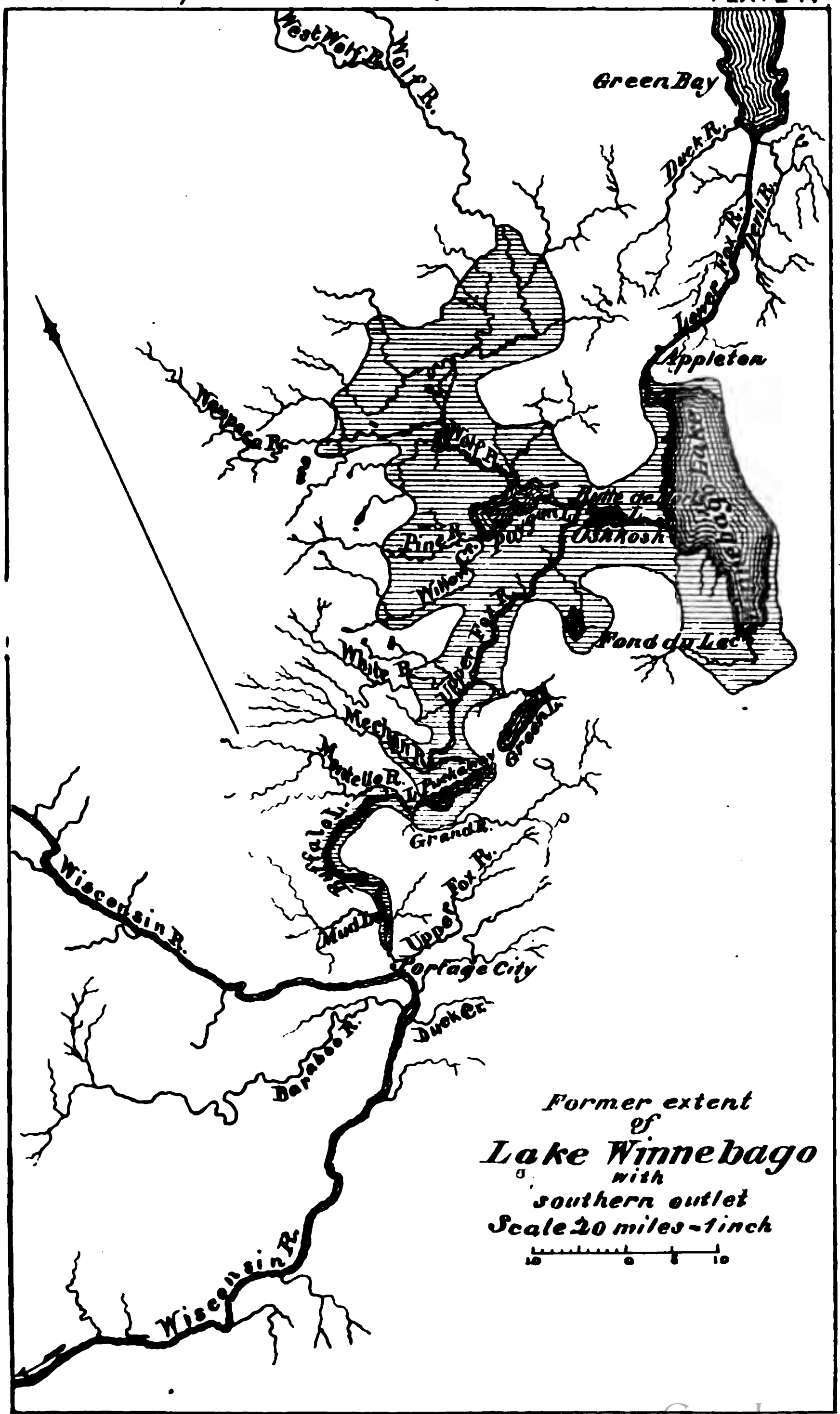
A like change of direction appears to have taken place in the drainage of the four lakes near Madison, Wis. These lakes now drain to Rock River, but formerly, I think, to the Wisconsin, along the valley of Black Earth Creek. The summit between this creek and the largest of the lakes, Mendota, is but little elevated above the lake, and is composed of the same pure white sand as is found along the margin of this lake, whence it was probably brought by the former southwestern outlet. So little is this upper portion of Black Earth Creek separated from the lake, that some years ago the building of a road and washings from cultivated land caused so much submergence of fields near the summit, by raising the level of a small lake about 2 feet, that the owners of this land cut a ditch to drain the waters the other way into Lake Mendota. This led to an injunction by a mill-owner lower down on Black Earth Creek, and after much litigation the final decision of the higher court was that the digging of this ditch must be stopped, and the obstruction which caused the overflow removed.

Explained by the same hypothesis, which is applicable to an extensive area.—The natural change in the direction of the drainage here can be explained by the same hypothesis made for the change of flow of the Upper Fox River, both of which are a part of a wide-spread exhibition of similar changes. It was first announced by me at the Chicago meeting of the American Association for the advancement of Science, in 1868. It was also reported by me in outline in the annual report of the Chief of Engineers of that year.

CHAPTER V.

METHODS OF IMPROVING NAVIGATION.

PRELIMINARY REMARKS—Relations of the United States and corporate companies to the improvement—Difficulties heretofore not appreciated—Influences controlling former plans and operations—Future plans based on the new data—IMPROVEMENT BY CANALIZATION, REGULATION, OR RECTIFICATION—Hydraulic formulæ applicable—The Humphreys-Abbot formulæ adopted—Small practical bend effect—Width of rectified river at low water for different depths—Slopes for uniform depths and different widths—Requirements which must be met in works of construction for river rectification, so as to produce a desired navigable depth at low water—Conditions demanded at high water—How to begin the work discussed and illustrated by example—Section of regulated river for both high-water and low-water channels—Further protection against scour—ESTIMATE OF MONEY AND TIME REQUIRED FOR CANALIZING IMPRACTICABLE—Conclusions to be drawn from the success attending similar works on the Garonne—Example in the case of the Ohio River—Conclusion with regard to canalization of the Wisconsin River—IMPROVEMENT BY MEANS OF RESERVOIRS AT THE SOURCES—Doubtful possibility of success—Immense cost—Great danger attending such works—METHOD OF IMPROVEMENT BY DAMS AND LOCKS—Difficult and



Former extent of Lake Winnebago with southern outlet
Scale 20 miles = 1 inch

expensive, if not impracticable—Never reccommended, and special data not obtained for depth to bed-rock—IMPROVEMENT OF NAVIGATION BY MEANS OF CANAL ALONG THE VALLEY—Data for making location—Provisional location—Objectionable features, and alternative to avoid them—CHARACTER OF CANAL AND LOCKS—Description of locks, with general directions as to construction—Bills of lock-material—Estimated cost of a lock—Summary of cost of all the lift-locks; of all the guard-locks—Cost of feed-weirs connected with lock; of feed-pipes; of culverts; of waste-weirs; of bridges; of walling; of riprap; of grubbing; of clearing land; of engineering, the work to be done in two years—Grand total cost—Additional cost for five feet draught—Annual expense of superintendence and repairs.

PRELIMINARY REMARKS.

So far in this report I have been presenting the data and experience obtained from our surveys, and from the study of previous operations, to enable us to meet the question of further improvement. I have been uninfluenced by committal to any plan to which consistency might induce me to adhere beyond its intrinsic merits, and I have resisted the pressure for an immediate plan of operations until I could fully make up my mind as to what was practicable by elaborating our data, and thus be enabled to make a proper comparison of the Wisconsin with other rivers where improvements had been made, and be enabled to arrive at conclusions that should not be delusive.

Relations of the United States and corporate companies to the improvement.—At the time the work was under my charge as an officer of the government, the route from Green Bay to the Wisconsin was under the control of a private corporation, and my investigations after 1866 were designed to furnish a plan for improving only the portion of the route along the Wisconsin. It is to that part I shall confine my attention in this chapter.

Difficulties heretofore not appreciated.—I have felt much concern in trying to find a suitable plan of improvement which should be acceptable to the public, for, from the first attempts at improvement till now, as shown in Chapter III, the difficulties have not been fully presented, if even understood. Year after year responsible persons charged with providing plans for making this improvement have regarded it as an easy matter, and in a few instances have applied with confidence such insufficient means as have been productive of no permanent benefit, and in fact so insignificant in themselves as to make it a matter of research to find out where they were employed.

Influences controlling former plans and operations.—The neglect to attempt more improvement of the Wisconsin arose mainly from the fact that in its natural condition the navigation was so much better than on the Fox Rivers, that its improvement was not so pressing a need as that of the other portions of the route. The United States law made the grant of lands proportional to the length of the route, excluding the distance along the Wisconsin; and although the legislature of the State required one-sixth of the proceeds of the sale of the lands to be applied to the Wisconsin, only a small proportion was actually thus used, as the whole was inadequate to the improvement of the route along the Upper and Lower Fox and the Portage Canal. To sustain the course adopted it is probable the managers represented the Wisconsin River in the best light they could, and their wisdom cannot be questioned in improving the Fox Rivers first. When the improvement passed to the control of a company it was not expected to improve the Wisconsin, and its financial necessities always inclined it to put the best face possible on this river's navigability. This influence was also brought to bear upon me early in these investigations, to induce me to attempt something at once;

and while distrusting our ability to adequately improve the river itself, I suggested a method of operating by which it could be tested without great expense, and at the same time enable us to find out whether we could use the bed of the river for making crossings from a canal on one bank to one upon the other, should the canal plan be adopted.

Congress, in 1871, completed the legislation which enabled this trial to be made, but the control of the work had passed out of my hands. The engineer in charge consulted me on the subject, and proposed to follow my plan; but from the shoalness of the river he met with obstacles which compelled a modification of it, and the success which attended his work in 1871 led him to believe that any required depth could be produced by improvements in the river-bed, and my plan was abandoned. That these promises of success were illusory is apparent from subsequent experience, which has much reduced them, and I believe they must grow smaller until they are of no value.

Future plans based on the new data.—By means of the data obtained from our surveys and investigations, as exhibited by the descriptions and tables in the preceding chapter, and on the maps and diagrams there enumerated, we are enabled to take up the consideration of the improvement with facts at our command not possessed by any one before; and, if properly weighed and put together, they should give us more reliable conclusions. These we will now attempt to reach.

IMPROVEMENT BY CANALIZATION, REGULATION, OR RECTIFICATION OF RIVER.

The first method which has always suggested itself is that of contracting the water-way, thus increasing the depth, and, by confining the action of the water to a narrow channel, enable it to keep this free from sand or other deposit. This method, when most fully and successfully applied, consists in giving new banks to the river adapted to the end sought, and is known technically as the canalization, regulation, or rectification of the river.

Hydraulic formulæ applicable.—The flow of the water in such regulated rivers is subjected to uniformity of conditions that admit of the application of mathematical formulæ, and by these we may approximately proportion the dimensions of our proposed channel to meet the object in view, which, in our case, is to obtain a continuous proper navigable depth at low water. In the proposed problem of rectifying the Wisconsin, the survey has determined the volume and the slope which the present river has and which the improved river should have, and we may, therefore, give it the width which will maintain the desired depth. We have no way of determining this width except by mathematical formulæ or by expensive experiment, and we should, at least, do the best we can with the former as a preliminary step toward the latter.

There are two specially important requirements of a rectified river. It must be small enough to give the required depth at low water, and large enough to carry off the volumes of the floods, and arrangements must be made to secure the return of the stream to the low-water channel provided for the river on its reaching the low-water stage.

Here we have, in seeking for the required dimensions by the formula, to depend entirely upon the correctness of the factor in it representing the *slope*, the most subtle of all the quantities entering it. Disregarding for the present the effect which the new currents of the improved channel may have in destroying the permanency of the river-bed, we see that if the formula used should not properly express the effect of

resistances—that is, for instance, that only part of the slope used according to the formula was found actually necessary to carry off the water in the regulated channel—then the unemployed portion of the slope would give increased velocity and diminish the depth. On the other hand, should it be found in practice that more slope than is called for by the formula at high water would be needed to move the floods, we would subject our new banks to inundations and dangerous injury. Large margins for safety in both directions must be allowed for, at best, in locating our new banks, but we are much less liable to error from the inapplicability of the formula than we are from the scour in the river-bed destroying that uniformity which it is our aim to give, and on which the applicability of all formulæ is based. This question of maintaining the uniformity of the bed will be specially considered after we have determined by the formula the proportions the new bed should have.

The Humphreys and Abbot formulæ adopted.—As there are peculiarities under which all formulæ for rivers have been deduced, it is generally expected that the engineer in adopting one shall establish its applicability to his case. Feeling every confidence in the deductions of the "Physics and Hydraulics of the Mississippi," by Humphreys and Abbot, I yet endeavored to find confirmation of them on the Wisconsin, and especially on the Mississippi, near Saint Paul, where the conditions of the two rivers were similar, but under circumstances more favorable to the latter place for making nice observations. The natural difficulties at both places proved very great; so that while everything we could fairly conclude sustained the Humphreys and Abbot formulæ, these conclusions were not in themselves based upon observations that could add much weight to the evidence of their truth given by the authors of these formulæ, except as to the parabolic law of change of velocity from surface to bottom, which was fully sustained.

There was no part of the Wisconsin River, as we surveyed it, where uniform conditions existed through a distance that gave a possibility of measuring the corresponding slope, so no direct test of formulæ involving slope could be made. I have, therefore, taken several sections where the volume was known, and have applied the Humphreys and Abbot formulæ, to see what slope the river would have if it were straight and uniformly of that section. Irregular as these sections are, they furnish a much nearer approach to uniformity than the average of the river. In a majority of cases the river is so divided and spread out that, as far as the application of formulæ is proper, it is divided into several streams. The result is given in the following table:

Table of measurements on the Wisconsin, with column of calculated slope, deduced by application of the Humphreys-Abbot formulæ, showing the slope the river would have if uniformly of that volume and section; dimensions in feet.

Miles below Portage.	Discharge in cubic feet per second.	Area of section.	Mean velocity.	Width.	Wetted perimeter.	Hydraulic mean depth.	Slope.	Slope in feet per mile.	Height of surface above low water, 1867.	Remarks.
		a.	*v.*	*w.*	*p.*	*r.*	*s.*			
0.0	3360	1954	1.72	361	363	5.4	.00003586	0.189	0.25	
0.0	2765	1652	1.673	589	590	2.8	.00012020	0.63	0.12	Part of river]
2.0	3679	1762	2.088	353	356	4.96	.00008914	0.47	0.05	
7.0	3558	1280	2.780	270	287	4.46	.00031360	1.655	0.1	
8.0	3658	2030	1.743	759	761	2.66	.00016250	0.858	0.1	
15.5	3558	2730	1.303	300	316	9.1	.00000443	0.0234	0.1	
18.3	3275	2334	1.375	2040	2043	1.14	.00032470	1.714	0.0	
19.7	3275	2034	1.610	380	387	5.35	.00002898	0.153	0.0	
20.1	3275	2680	1.222	1900	1902	1.41	.00017040	0.900	0.0	
22	3275	1554	2.108	439	441	3.50	.00018770	0.981	0.0	
29	3210	1037	3.075	332	333	3.1	.00102500	5.41	0.0	Part of river.
29	3210	1554	2.065	390	392	3.964	.00013550	0.715	0.0	Mean of six sections.
57	6557	2059	3.184	364	367	5.75	.00033420	1.765	1.1	
61	5942	3241	1.833	912	915	3.5	.00003293	0.174	0.9	
75	5944	1896	3.135	480	485	3.95	.00068480	3.615	0.7	
79	5944	2701	2.201	642	645	4.0	.00015490	0.8178	0.7	
87	6568	2354	2.79	513	515	4.57	.00031970	1.687	0.65	
95	6568	3518	1.867	1700	1703	2.07	.00035680	1.884	0.75	
101	8111	2886	2.81	325	328	8.8	.00008476	0.4475	0.9	
110	2912	1493	1.944	501	504	2.96	.00019703	1.0403	0.7	River in two channels.
110	4065	2280	1.778	635	638	3.5	.00009327	0.4925	0.7	Do.

The sections of the river used in the preceding table were taken, except in two cases, where the water-way was not divided by islands, and in most of the cases the conditions were more than usually favorable to the flow of the water, thus requiring but little slope of surface. In one-third, however, the slope required, as deduced by the formula, exceeds the average slope of the river, and there is no doubt that if the sections taken represented a true average of the sections of the river, the above ratio of one-third would be increased. There can be no direct comparison of these deduced slopes with the measured slopes, because these latter are averages over considerable distances, while the calculated slopes are only for the immediate section. We can conclude, however, that the formula contains the proper factors for giving us the slope under all these fluctuating conditions, since it gives low slopes and high slopes, as nearly as we can ascertain, under the same conditions in which they exist in nature. Having, then, the volume at low water and the total descent of the river fixed, we may reasonably depend, to a very considerable extent, upon the formulæ of Humphreys and Abbot for determining the mean velocity and corresponding width and depth of the river when canalized or reduced to uniform conditions.

Small practical bend-effect.—In regulating the stream it would, of course, be best to preserve the natural curves when not too sharp for navigation, and even increase them, when allowable, for the purpose of diminishing the slope by developing the low-water length of the stream, and also to consume a portion of the effect of this slope in overcoming the resistances of the bends. Unfortunately, we can do but little in this way, because the width required for the stream at high water, in some places, will occupy the whole available portion of the valley, and we could not allow the low-water channel to differ materially in direction from that at high water, without subjecting it to be filled up. The bend-effect, in consuming the slope in the rectified river, will be too

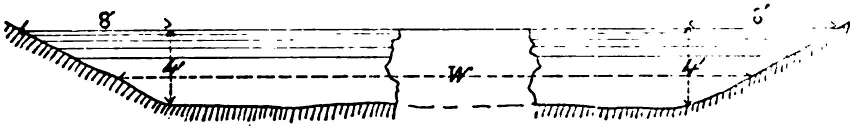
small, as shown in the preceding chapter, to make it worth while to attempt to account for it before applying the deductions of the formula.

Width of rectified river at low water for different depths.—The original formula adopted to determine the width of the regulated river of required uniform depth is given on page 312 of the "Physics and Hydraulics of the Mississippi," No. 38, as follows:

$$p + W = \frac{195\, a\, s^{\frac{1}{2}}}{[0.93\, v + 0.167\, b_{\frac{1}{2}}\, v_{\frac{1}{2}}]^2}$$

In this W is the width; p the wetted perimeter; a the area of section; s the slope; v the mean velocity; $b = \frac{1.69}{(r + 1.5)^{\frac{1}{2}}}$. In this value of b, r is the mean radius.

The draught of water it is proposed to have at low water is in the neighborhood of four feet, with side slopes of 1 upon 2, thus:



In this case $p = 1.01\ W$, nearly; W being the mean width, r will be the depth nearly; $r\ W$ will be equal to a; $v = \frac{Q}{r\ W}$, Q being the volume of water discharged in cubic feet per second.

Substituting these values in the equation for $p + W$, and solving with reference to $W_{\frac{1}{2}}$, we have—

$$W_{\frac{1}{2}} = \frac{0.1305\, b^{\frac{1}{2}}\, Q^{\frac{1}{2}}}{2\, r} \pm \sqrt{\frac{0.7267\ Q}{r^{\frac{3}{2}}} + \left(\frac{0.1305\, b_{\frac{1}{2}}\ Q}{2\, r}\right)^2}$$

In this value of $W_{\frac{1}{2}}$, where the river is as small even as the Wisconsin at low water, the second term under the radical sign may be omitted, and in large streams both terms containing b may be neglected. Letting $Q = 2{,}800$ cubic feet per second, as at low water at Portage, and with r varying from 2 to 10 feet, we obtain the following table:

Table of widths and velocities corresponding to different depths.

Depth in feet.	Width in feet.	Area of section in sq. feet.	Mean velocity, feet per second.	Probable maximum velocity.	Remarks.
2	790	1,580	1.772	2.215	Maximum velocity was obtained by increasing the mean one-fourth.
3	430	1,290	2.170	2.713	
4	275	1,100	2.545	3.183	
5	195	975	2.872	3.591	
6	149	894	3.131	3.914	
7	118	826	3.389	4.236	
8	96	768	3.646	4.557	
9	80	720	3.888	4.860	
10	68	680	4.117	5.146	

Slopes for uniform depths and different widths.—The mathematical condition under which the above table has been calculated requires uniformity of volume, slope, and cross-section, giving, with an unchanging

bed, uniform widths and depths. But as uniformity of depth is the essential for navigation, and as uniformity of bed and slope cannot be always, if ever, attained, we may, where the river-bed is unyielding, narrow the width and increase the slope and velocity, and still secure the depth there, thus allowing us to somewhat widen the bed and diminish the slope at other places. How far this may be done is shown by the succeeding table, giving slopes and velocity for a volume of 2,800 cubic feet per second, so as to secure a uniform depth of 4 feet, with width corresponding to the different mean velocities up to 5.81, and maximum velocity of 7.25 feet per second, or 5 miles an hour, which should not be exceeded. This value of s is deduced by means of the Humphreys and Abbot formula (36), page 312, "Physics and Hydraulics of the Mississippi," as follows:

$$s = \left[\frac{(p + W)(0.93\,v + 0.167\,b_{\frac{1}{2}}\,r_{\frac{1}{2}})^2}{192\,a}\right]^2$$

in which the quantities are the same as noted in this report when giving the formula for $p + W$.

Table of slopes and velocities for a uniform volume of 2,800 cubic feet and uniform depth of 4 feet, with corresponding widths.

Widths.	Area.	Velocity.		Slopes.		Remarks.
		Mean.	Max.	Sine of	Feet per mile.	
275	1,100	2.545	3.181	000298	1.57	
225	900	3.111	3.888	.000648	3.42	
175	700	4.000	5.000	.001735	9.16	
150	600	4.666	5.833	.003068	16.199	
135	540	5.185	6.471	.004641	24.50	
120	480	5.810	7.250	.007214	38.00	5 miles an hour.

If, now, our problem were to construct a channel which should carry all the low-water volume of the Wisconsin River by keeping near the natural slope of the valley, and give a channel navigable for vessels drawing 4 feet, and without locks, we know by consulting the last two tables the limiting hydraulic conditions which belong to it.

It must be noted by those investigating and considering this question of improving navigation that the above tables exhibit the best results we have any reason to hope for, at low water, near Portage, even with the greatest success in works of construction. Everything that can be measured is given as the result of actual measurements. The depths and corresponding widths, with this volume and this slope, are given in the first table; the variations the slope may have with uniform depths and different widths, in the second table—both from the best of formulæ for uniform motion of river-water. I have not extended the presentation to any but the low-water volume at Portage. For any other low-water volume at points lower down on the river, the widths for different depths and the same slope can be obtained near enough for our purposes by the simple proportion: As the volume used in the table (2,800 cubic feet per second) is to the other volume, so will the corresponding widths be for the same depth, &c.

The manner in which it should be practically executed will next be considered. It is a subject which may be further considered in a variety of ways, and I take the order which to my mind appears most natural. Others must make allowance for individual idiosyncrasies in endeavoring to follow me.

I will continue to confine myself at first to the conditions of low water, for this is so common in the Wisconsin, and exists during so much of the year when navigation is most needed, that any plan which is inadequate to ordinary low water must be given up.

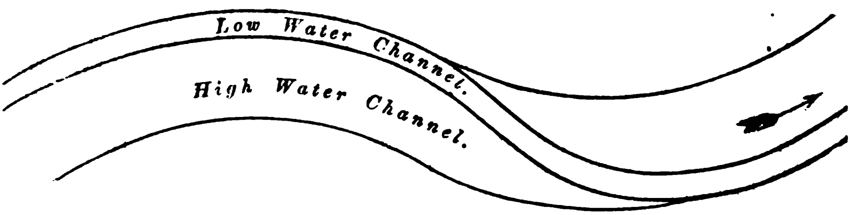
Requirements which must be met in works of construction for river-rectification so as to produce a desired navigable depth at low water.

1st. The water-way must be so contracted as to give the required depth at low water.

2d. The works for improving the low-water navigation must not make navigation dangerous at higher stages, must provide for the proper discharge of the water in flood-stages, and must secure the return of the river, at the recurrence of low water, to the channel provided for it.

3d. The velocity of the water at all stages must be so small as not to injuriously scour or disturb the material forming the bed of the improved river.

By the data and calculations already given it is clear that a greater navigable depth than 4 feet is mechanically impossible, without reducing the average width to less than 275 feet, and this is as narrow as, if not narrower than, the interests of steamboat navigation will admit. To make this contraction we must prepare entirely new banks for the river. Experience on the Rhine, Garonne, and elsewhere in Europe has shown that straight lines for the banks should be avoided as much as possible, and that the banks should be composed of curves imperceptibly passing from one curve to another as the curvature increases or decreases or reverses. One reason for this is that such disposition of the banks confines the action of the current to one side of the river—the hollow of the bend—and renders protection to the other side less needed. In rivers thus regulated the most difficult places for navigation occur at the points where the curve reverses, as the river passes from one side of the valley to the other. Sharp bends should be avoided, because they render reversals of curvature more frequent, are more difficult to navigate, and they produce more violent action of the current in scouring the banks and bed. No fixed rules can be laid down for determining the curvature, but it must depend upon the judgment at each place in meeting the conditions presented. In all the bends the low-water channel is naturally located on the concave side, so that on that side the high and low water bank can be the same; but in passing from a bend on one side of the valley to the other the low-water channel must cross the high-water one, and here great difficulty will be found in freeing the low-water channel after a flood-stage. (See diagram.)



Conditions demanded at high water.—Suspending the further consideration of the low-water channel, we will take up that of the proper width for the high-water channel. It is evident that to secure a low-water channel we must control the course of the river at high water so that it shall not at that time cut out a new route for the water, and

leave our low-water channel buried beneath the sand as the water falls. I have taken the high-water width for the first thirty miles to be that of the natural river at Skinner's Bluff, about 1,200 feet. It will have to be greater below that point, and if it should be necessary to have it wider at and above Skinner's Bluff, the natural river will in places require widening. The reason why it may require widening is that we cannot leave the present high-water bed unchanged, but must put in it such constructions as shall make it of a permanent form, sloping toward the low-water channel. The diminution of section which these works will cause it is expected will be compensated by the diminished resistances to the flow of water in the river of uniform width with sectional area and by the increased depth by scour at shoal places. Such results have attended river rectification elsewhere. The high-water volume at Skinner's Bluff is 61,200 cubic feet per second; the mean radius, 11.5 feet; mean velocity, 4.46 feet per second; and maximum velocity about 6 feet per second, or 4 miles an hour. We may expect the occasional occurrence of higher velocities at places, especially in ice-gorges. The bend-effect of the improved channel for high water will be about the same as for the natural river.

How to begin the work discussed and illustrated by examples.—The natural course of procedure, I believe, is to lay out and build new high-water banks first. This is somewhat the way it was begun in very remote times by the riparians on the Garonne, for the simple purpose of securing an increase of cultivable area; and when, in the present century, it was taken up by the Government of France and pursued systematically, the contraction of the natural river had in places gone far enough to enable the new low-water banks to be begun so as to improve the low-water navigation. The increase of cultivable-land area was still an object to be accomplished, the benefit to navigation being made subsidiary to it. Great care was taken not to raise the high-water banks so fast as to prevent the free admission of the silt-laden water to the low-lands, sloughs, and marshes farther from the river. The water was allowed to course slowly through these parts, and they were covered with cross-lines of stakes and wattlings and willow-plantings, to catch the suspended sediment, and by its deposit raise the level. So slow was this course of building up, that from 1833, at which time the work was begun under M. Baumgarten, down to 1848, as reported by him, only 34 miles of the river had been rectified.

This slow rate of progress would be fatal to any similar attempt to improve the Wisconsin. Moreover, it could not be applied because of the lack of silt in the waters of the Wisconsin, which could be used to build up the low lands, and, besides, the value of the land, even if gained, would not at all equal the expense. Furthermore, it may be noted here that the contraction to which the low-water channel of the Garonne was subjected is not half what will be needed to obtain the navigable depth at low water which the navigation of the Wisconsin demands.

Being then, from the conditions of our problem, unable to realize the benefits of the slow process on the Garonne, nor to stand the delays incident thereto even if we could realize the benefits, we are at liberty to construct the new high-water banks artificially at once, at such rate as is allowed by the means at our command and by the time required for the natural forces to adapt themselves and the included river-bed to the new banks given to the river. Experience has abundantly shown, in our western rivers of alluvial beds, that if by artificial works we deprive the natural bed of a portion of its area, the next high flood enlarges it again by

removing an equivalent amount from some other place. My own investigations of the effect of the building of the high bridge-piers and embankment, by Mr. Sewall, at Saint Paul, and the building of the levees on the left bank by that city, show that an equivalent was taken from the opposite or right bank and the included island. This law of compensation is also noted by Mr. T. C. Clarke, in his valuable report on the construction of the Quincy bridge. It has also been noted as shown by the works at several other bridges, as at the bridge at Saint Joseph, on the Missouri River, and its auxiliary works, and at the Mississippi bridge at the town of Louisiana, Mo. Many other places might be named, but the most marked instance is that at Saint Louis, where the Mississippi, with its great volume, has been confined to a channel but little exceeding 1,500 feet in width by works on both sides and in the bed, and where the compensation is made by excavating the bed at high water.

It must be noted in all these examples that the contraction was over but a small space along the river, and that, therefore, it was but comparatively a small work for the river to free itself, and that the sand removed was soon so distributed as to find a resting-place where it would not produce noticeable effect.

From the foregoing facts and remarks we see that in building the new high-water banks for the Wisconsin, which we should do at low water, we shall compel it to enlarge the included space by deepening, and we must not build more between any two floods than the next one can safely clear, and from which it can remove the effects of the contraction. Suppose, for instance, we build 5 miles of new high-water bank during one spell of low water, and that the succeeding flood be a full one. The enlargement by the moving of sand would begin all along our contracted portion, but would not at first be felt in any but the upper portions, which would supply the lower with sand as fast as it was removed. The enlargement would, therefore, pass from the upper part downward, and in the mean time the water must be raised in the lower portion in proportion to the contraction as long as it exists. It is obvious, then, that this will set a rate to our progress, for if we build too much we will have to raise, for each extension, the lower end of the new bank very high to prevent its being overflowed and destroyed before the enlargement by the flood will have been completed, and, if it stands, it will be much higher that the finally regulated river will need, and we shall have gained time only at great expenditure. It must not be left out of sight, in this connection, that the extreme floods in the Wisconsin are very rare. The ordinary flood only rises 6 feet above low water; the high ones 10 feet. One has a volume of 29,390 cubic feet per second, the other of 61,200 cubic feet per second. Our river-work for high-water banks may, then, not be fully tested for several years, and it seems to me that it would be very hazardous to build more than 10 miles at a time until that part should have been fully tested and adjusted. Analogous experience is frequently had in covered ways for streams in passing through cities, which, having capacity suited to ordinary rains, are burst up and destroyed with much attendant destruction during heavy rain-falls. Great as are the difficulties of constructing the new high-water banks for the Wisconsin, which must be continuous on one side, at least, all the way—often in the present river-bed and sometimes on both sides—let us suppose that by perseverance and ample means they are finally overcome, and that we have a section of high-water banks for 10 miles along the river, at the upper end of the proposed improvement, done, and its capability to maintain itself established. Such bank might be built as an ordinary levee of proportions suited to its height, and thoroughly re-

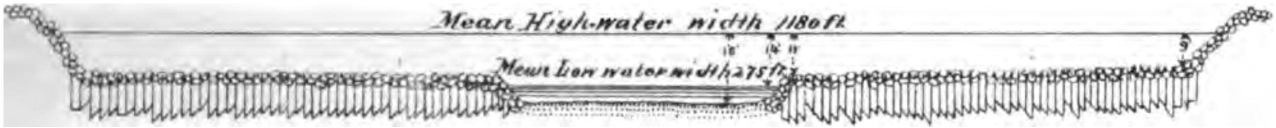
vetted on the river side with riprap stone or stone and brush. As soon as this 10 miles was done the formation of the low-water channel might be begun along it, regard being had to the fact that the effect on this portion, regulated for high water, would be to lower the bed through it and a short distance above, and to raise it below, so that, as the extension downward was made, the lower part of the first division of 10 miles would be lowered too.

Section of regulated river for both high-water and low-water channels.—We design the area of the section at high water, for the first 30 miles, to be nearly that of the natural high-water section at Skinner's Bluff; for the present canal should be brought down to at least below the mouth of the Baraboo River, and below that there is no considerable affluent for this distance. At this bluff the width is 1,180 feet, with average depth of 11.5 feet, giving an area of 13,570 square feet. Our proposed low-water banks should be 2 to 3 feet higher than low water, so that with the least accession of water we could get a depth of 6 feet for navigation. (The low-water banks prepared for the Garonne are 9 feet above low water, which is three times that proposed here—that river rises 30 feet above its low water, so that the ratio of the high and low water bed is the same.) Above that height the rising river should be allowed to spread rapidly, merely giving the bed such a gentle slope as will direct the water back to the low-water channel when the river falls. This influence of the high-water bed will be most needed at places where the low-water channel is crossing from the high-water bank on one side to that on the other. I would propose to give shape to the high-water bed at these places by driving rows of sheet-piles transversely to the stream between the high and low water banks, and cutting them off evenly, so as to give a slope rising about 2 feet between the low-water channel and the main bank. These piles would need to be bolted together by stringers, and protected by riprap down to a depth of from 3 to 10 feet from their tops on both sides, but particularly on the lower side. The distances of these rows apart, and the depth to which the piles must be driven, will vary with circumstances. The low-water banks themselves, when not forming a part of the high-water banks, must be strongly built of suitable material, such as heavy piles and riprap. Special precaution must be taken on the Wisconsin on account of the ice, which alone would have greatly modified the work on the Garonne had it had the same climate. The same thing must be said about the aid to be secured from the growth of willows—for while they grow in both climates, it is at a much slower rate on the Wisconsin than on the Lower Mississippi, to which latter climate that of the Garonne may be compared.

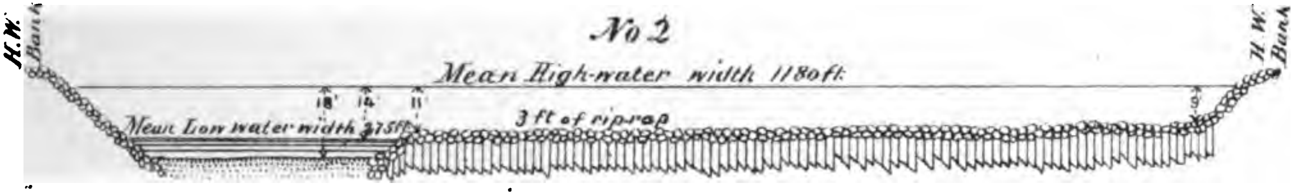
The length of the new low-water-bank line would on one side equal the length of the river, and there would have to be two banks at all the places where the low-water channel crossed from one high-water bank to the other. The tie-lines between the low and high water banks would have to be at such distances apart as to keep the river in its place, and would be closer in proportion as there was greater force in the water to make a channel elsewhere. On the Garonne these distances apart varied from 130 feet to 325 feet.

The two diagrams, Plate V, represent sections of the river improved in the manner here considered. No. 1 is at a place where the low-water channel is in the middle of a crossing-place between the high-water banks with tie-banks between the low and high water banks, as already described. No. 2 is a section where the low-water channel is in a bend on one side of the high-water channel, the centrifugal force tending to

No 1



No 2



Characteristic section
of the
Wisconsin River
when
Canalized to give 4 ft. draft. at ordinary low water

Horizontal scale — 100 0 100 200 feet

Vertical scale — 10 0 10 20 30 feet

Low water volume 2800 cu.ft. per sec. mean width 275 ft. mean velocity 2.545 ft. per sec. slope .000285
High " " 61200 " " " " " 1180 " " " 4371 " " " " .000285

keep the water in the concave bend. I have in this illustration given the tie-line the same rise from the low-water bank to the high-water bank opposite the bend, as in the previous case, thus making the slope of the high-water bed toward the low-water channel only half the amount allowed in the first case. Notwithstanding the effect of the centrifugal force to keep the deep water in the hollow of the bend, it is sometimes insufficient to prevent the low-water channel in rivers with sandy beds from cutting across the points, so that tie-lines of piles may be needed there.

Both these sections have a high-water area slightly in excess of that we have considered in our calculation, but are thus taken to avoid fractional dimensions.

To give now, in brief, what must be done to secure a reliable and sufficient low-water navigable depth in the Wisconsin River by contraction. we will take the river to have an average width of 1,200 feet at high water, and reduce it to a width of 300 feet at low water. The low-water tie-banks must average a distance apart not greater than 300 feet, and taking both sides of the low-water channel, an average length of 900 feet; that is, they will be equivalent in combined length to three times the length of the river. The lengths of the low-water banks must considerably exceed that of a single bank the whole length, and this excess, together with the protections to the high-water banks, will require fully as much work as another low-water bank the length of the river. The contracting and protecting works will then reach, in combined length, five times the length of the river, or 590 miles, or 3,115,200 linear feet. No matter how built, this would cost in the neighborhood of $3 per foot, or $9,345,600. In this estimate the cost of building the high-water banks, which I have proposed in order to limit the field of operations for maintaining a low-water channel, is not included. It is not a necessity, but if it is not built, the extent of the low-water controlling works must be largely increased above what I have allowed. The progress of the work itself must be slow and tentative, waiting for the conforming changes of the river.

Further protection against scour.—With all these works thoroughly constructed and protected so as to withstand the floods, others must be used, if necessary, to prevent any local scour at high stages at points where the current from any temporary or local cause may become unusually strong, for the material thus scoured would be deposited at some other place, and probably in our low-water channel at the crossings. Whether such action could be prevented or not could only be proved by a long and expensive trial of some systematic plan like that I have presented. Experience on the Ganges Canal shows that inadmissible scour took place on sandy beds where the slope exceeded 15 inches per mile. This great canal has a volume of 6,750 cubic feet per second. It is 140 feet wide and 10 feet deep.

The danger that results from too much scour is, that deep holes form in some parts, with corresponding deposits in others, thus destroying the uniformity of the channel. At places of deposit the low-water channel will become engorged, the surface of the water will be raised and spread over our low-water controlling works, so that the navigable depth will be lost. The average slope is 18 inches per mile, and to get a depth of 4 feet we must have a velocity (calculated) at not less than 3 miles an hour. To get 10 feet of depth on this slope, we must have a maximum velocity (calculated) not less than 5 miles an hour, and this depth at least is what we know the Wisconsin has at high water, on an average slope of 18 inches per mile. Whatever the velocity may be

(whether more or less than 5 miles an hour), we have the authority of Major Baker, of the Royal Engineers, as quoted below from Colonel Cautley's report on the Ganges Canal, that the maintenance of a sandy bed on this slope, with this depth, was impossible, without involving extraordinary expense, which, rather than undertake, he modified many miles of canal already constructed, so as to reduce the slope to 15 inches per mile. Even this reduced slope has since been found too great. On the Wisconsin, then, we shall have to succeed in maintaining a sandy bed where the volume reaches 60,000 cubic feet per second, when, with the same kind of bed and a volume not to exceed 7,000 cubic feet a second, the English engineers abandoned the attempt, although having at their command the cheap labor of the millions of people of the Indian Empire.*

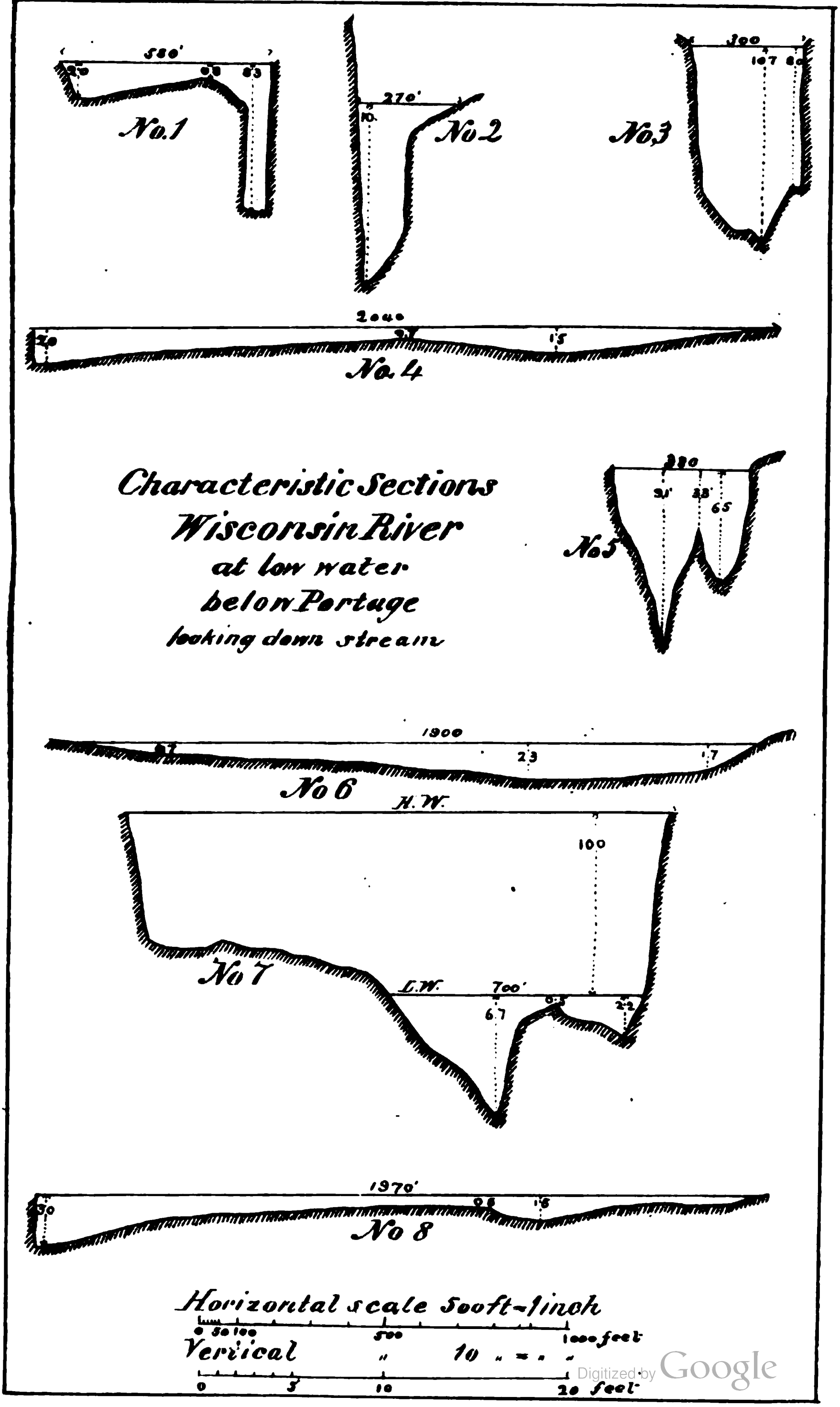
ESTIMATE OF MONEY AND TIME REQUIRED FOR CANALIZING THE RIVER IMPRACTICABLE.

In preparing the method of canalizing the Wisconsin now presented so as to endeavor to meet the requirements of the case, it was with a view to making an estimate of the cost and the amount of time required. What appeared as the most certain and direct in its results has been chosen. Notwithstanding this, the uncertainties as to length of time required, owing to the varying conditions of the river from year to year, prevent any reliable estimate of expense being made, even if the method itself was sure of success. The weight of experience elsewhere, however (of which I shall next give some example), is against the probable success of the method.

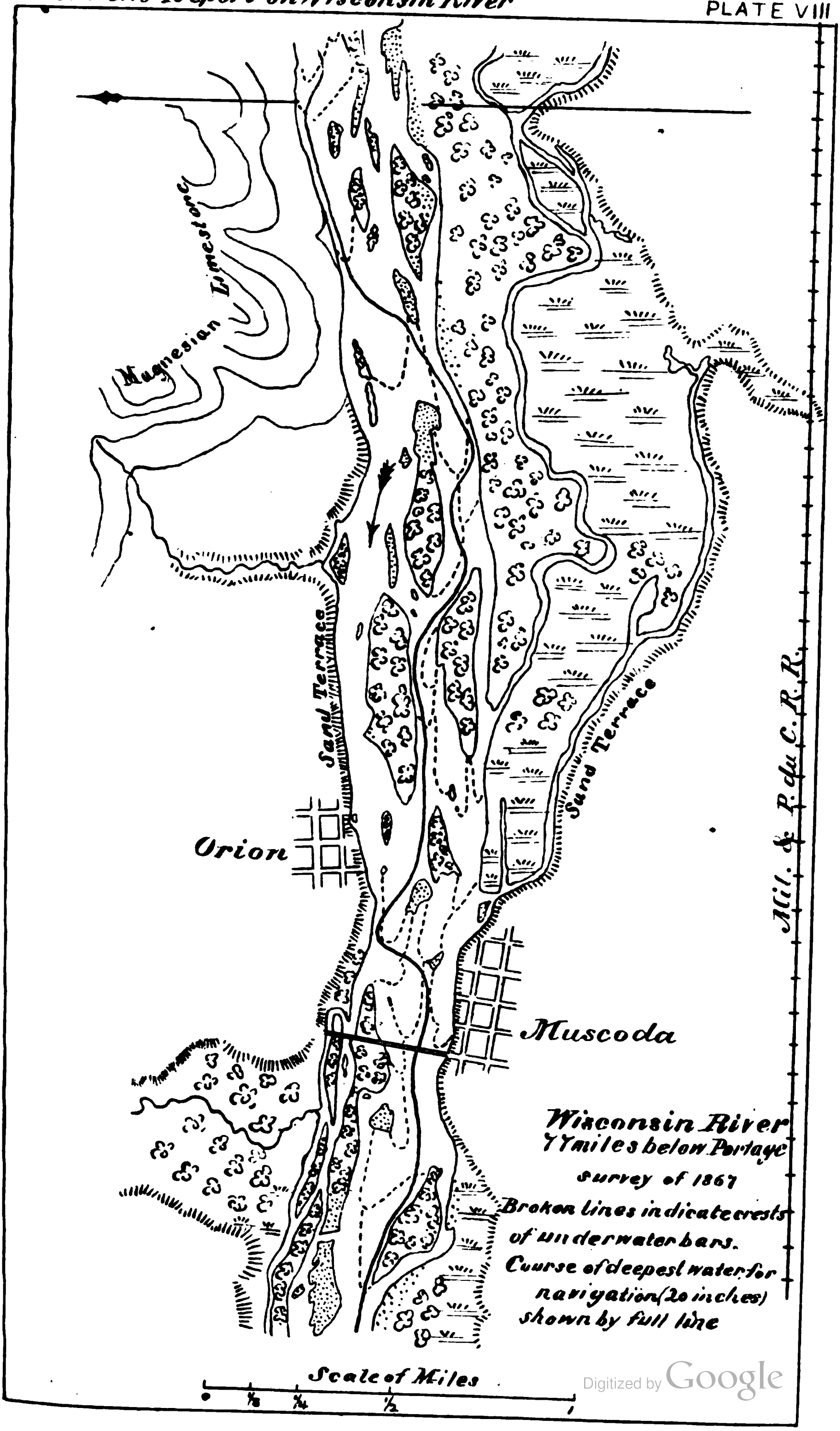
To enable the difficulties to be more easily comprehended, I have added to the text Plate VI, showing a few characteristic low-water sections, enumerated below:

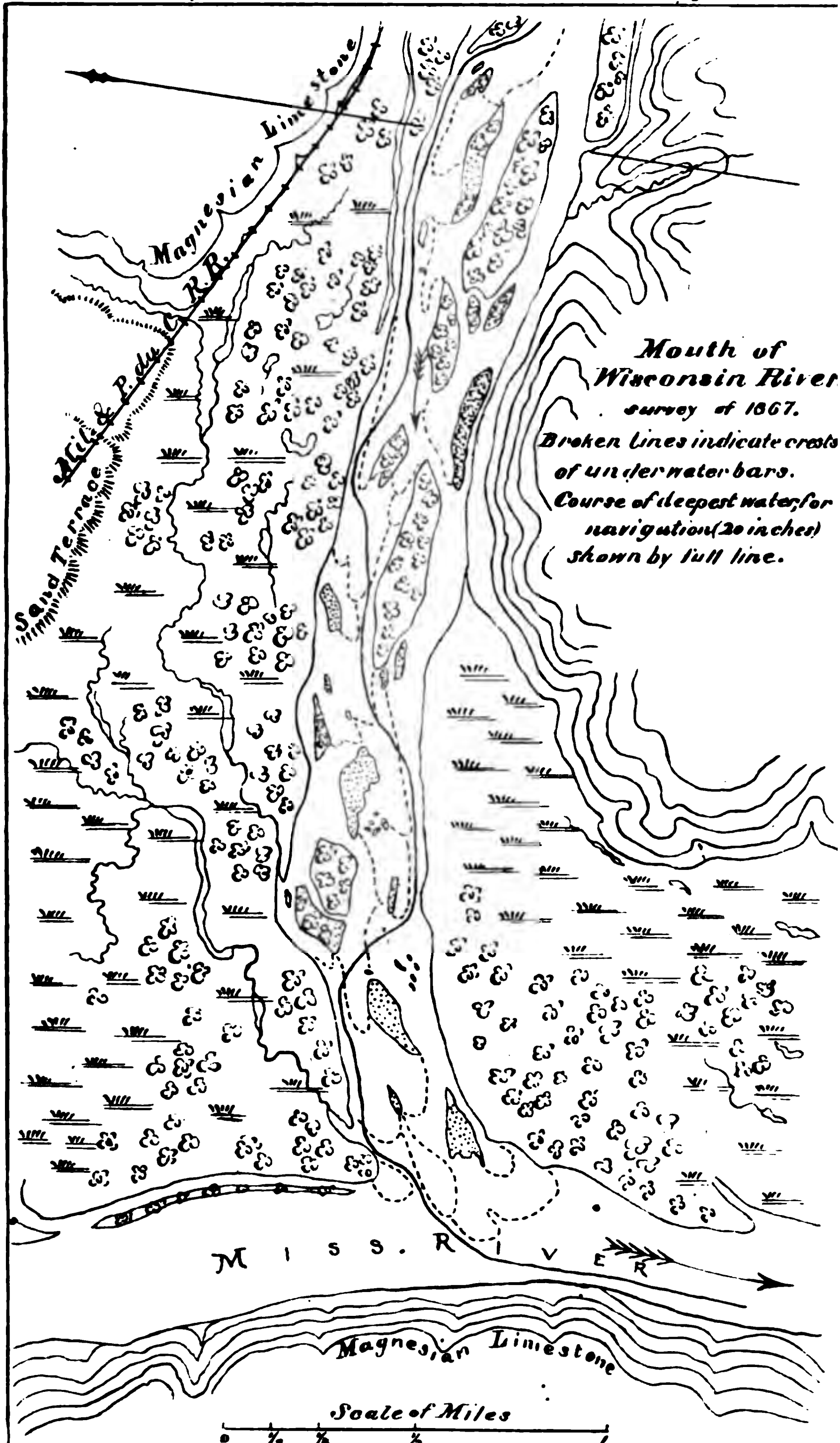
Section number.	Miles below Portage.	Area.	Hydraulic mean depth.	Remarks.
1	5	1460	2. 51	At sand-bar just above Baraboo River
2	7	1280	4. 74	
3	14½	2730	9. 1	
4	17¼	2334	1. 14	Across a sand-bar.
5	18¾	2034	5. 35	
6	19½	2680	1. 41	Across a bar.
7	23	1722	2. 43	
8	34	2207	1. 12	Bar just above Honey Creek.

*Colonel Cautley, of the Royal Engineers, in his report upon the Ganges Canal works, vol. 1, page 199, quotes Major Baker, of the Royal Engineers, as follows: "The slope of 18 inches per mile was under any circumstances excessive, but its maintenance on a good soil, aided by artificial expedients, was by no means considered to be an impossibility, or likely to involve expenses of an extraordinary nature; this could by no means be the case when the water was brought in direct connection with sand, or with lighter varieties of soil that the admixture of sand leads to, nor could the design for the masonry-works be considered appropriate to a channel where, although the surface of the bed might exhibit some trifling signs of durability, every foot in depth of excavation for laying in the foundations plunged deeper and deeper into sandy soil. The necessities for modification not only in width of water-way but in depth and solidity of foundations became under this evil apparent; and, although from the advanced state of some of the works in the neighborhood of Mungloor and Liburheri, a redisposition of slope became somewhat inconvenient, as necessitating an alteration of work which had already been done, I determined at once to remodel the whole of the slope on a reduction of 3 inches to the mile from the Roorkee Bridge to Nanoon."


580'
No. 1
270'
No 2
300
No 3
2040
No. 4
Characteristic Sections
Wisconsin River
at low water
below Portage
looking down stream
380
No 5
1900
No 6
H.W.
100
No 7
L.W.
700'
1970'
No 8
Horizontal scale 500ft = 1 inch
0 50 100
500
1000 feet
Vertical " 10 " = "
0
5
10
20 feet


Wisconsin River
34 miles below Portage
survey of 1867
Broken lines indicate crests of
under water bars
Course of deepest water for navigation (20 inches)
shown by full line
Sand Terrace
Honey Cr.
remains of old dam
Magnesian Limestone
Scale of Miles
0
1/8
1/4
1/2
1


Magnesian Limestone
Sand Terrace
Sand Terrace
Orion
Muscoda
Mil. & P. du C. R.R.
Wisconsin River
7 miles below Portage
Survey of 1867
Broken lines indicate crests of underwater bars.
Course of deepest water for navigation (20 inches) shown by full line
Scale of Miles
0
1/8
1/4
1/2
1


Magnesian Limestone
Mil. & P. du C. R.R.
Sand Terrace
Mouth of
Wisconsin River
survey of 1867.
Broken lines indicate crests
of underwater bars.
Course of deepest water, for
navigation (20 inches)
shown by full line.
MISS. RIVER
Magnesian Limestone
Scale of Miles
0 1/8 1/4 1/2 1

Also Plate VII, showing about 3 miles of river near Honey Creek.
Plate VIII, showing about 3 miles of river near Muscoda.
Plate IX, showing about 3 miles of river at the mouth.
The maps attached to this report show the whole river.

Conclusions to be drawn from the success attending similar works on the Garonne.—I have cited heretofore the case of the rectification of the Garonne, because it is one of the most successful examples of this method of improvement. Col. W. E. Merrill, United States Engineers, in his report to the mayor of Saint Louis, in 1869, in regard to the rectification of the Mississippi River at that point, says of it, after such investigation of European examples as his opportunities enabled him to make:

> From all that I have been able to gather from every source accessible to me, the river Garonne is the most complete specimen of a regulated river to be found anywhere, representing the most successful modern practice. The study of this river is particularly valuable, as the *Annales* (*des Ponts et Chaussées*) record its condition prior to the commencement of any work of improvement, and give a very complete history of the works and their effects from 1833, when they were begun, to 1848, when a large portion of the river (34 miles) had been successfully treated.*

The full account of this work on the Garonne up to 1848 is given in the memoir of M. Baumgarten, of which Colonel Merrill presents an abstract. This work I have consulted and had completely translated. The following comparison of the Wisconsin with the Garonne is presented, supposing the Wisconsin rectified to give a depth of 4 feet at low water.

Table of corresponding data for the Garonne River and for the Wisconsin, rectified to four feet depth at low water.

	Garonne.	Wisconsin.
Average slope per mile	1.4 feet	1.5 feet.
Volume at ordinary low water	5,800 cubic feet	2,800 cubic feet per second.
Volume at high water	272,700 feet	61,200 cubic feet per second.
Rise from low to high water	*30 feet	10 feet
Low-water width of rectified river	570 feet	275 feet.
High-water width of rectified river	1,950 feet	1,180 feet.
Draught at extreme low water	Depth not given, navigation suspended.	4 feet wanted.

*A flood of 33.6 feet is mentioned by M. Baumgarten, but the corresponding volume is not given.

To which may be added that the navigation of the natural river, in both cases, is suspended at low water; that the rate of progress of the rectification of the Garonne, after being regularly undertaken, was only three miles per annum; that the land reclaimed on the Garonne was of great value, while it would be of very little value on the Wisconsin; that there is little ice on the Garonne, and a good deal on the Wisconsin.

From this comparison we see that with such rectification of the Wisconsin as the Garonne has received we should not get at low water more than 2½ feet. (See preceding table of calculated depths and widths.)

Example in the case of the Ohio River.—The works of improvement on this river, in the space between Pittsburgh and Cincinnati, 466 miles,

* Mayor's message to the city council of the city of Saint Louis, April session, 1869, and other documents; also report of Col. E. W. Merrill, major Engineers and brevet colonel United States Army, on the harbor of Saint Louis, which includes the report of Capt. T. J. Cram, United States Topographical Engineers, made in 1844, and the report of Robert E. Lee, lieutenant Engineers, made in 1837-'38, on the harbor of Saint Louis. Printed for the city council, Saint Louis; George Knapp & Co., book and job printers and binders, 1869, p. 21.

are one of the best illustrations of improving low-water navigation, by contracting the flow of the water, which we have in this country. This part of the Ohio resembles the Garonne much more than the Wisconsin does. The range between high and low water is 35.6 feet at Pittsburgh, and 62.5 feet at Cincinnati. The coarse material forming the bed is due to the heavy scouring and transporting power of the large high-water volumes and depths. The works on the Ohio, however, have not been as systematic as in the case of the Garonne.

The public improvement of this river was considered by our government as early, at least, as 1808; for on April 4, of that year, the Secretary of the Treasury, Albert Gallatin, referred to it in a report which was printed by the Senate. In 1822, a board of engineers, consisting of General S. Bernard and Maj. J. G. Totten, reported upon its improvement.* This report compares the river to the Loire, and recommends low dikes to contract the stream. They say:

The expedient proposed above for obtaining a greater draught of water in the Ohio is the only one we can devise. The board, however, are not sanguine in their belief in its efficacy in all cases requiring remedy. It is certain that by the dikes and narrow passages the water may be deepened at any required point, but it is to be feared that in some places, at least, the locality may be such that the very materials thus carried off by the rapid waters may be deposited, when they become comparatively quiescent, in such a way as soon to form a new bar below. The very great importance of the object in view and the want of any other resource will nevertheless justify an experiment.

The first experimental dam to overcome a sand-bar was begun by Maj. S. H. Long, at Henderson Island, 200 miles below Louisville, and completed in 1825. It was 402 yards long, and cost $3,778.93. It was considered a success. The improvement of the river, by removing snags, was begun about the same time. The building of wing-dams at various places was begun and continued from this time annually up to 1839; the appropriations varied from $3,000 to $100,000, but a great deal of the money was expended in removing snags and rocks. The reports of the engineers in regard to the effect of the dams were generally hopeful as to what would ultimately be the result when the work should be thoroughly completed. But little benefit, however, was rendered, and the breaking and giving way of dams were continually reported. In 1839, Capt. John Sanders submitted an estimate of $312,000 for building dams in 1840.

In 1842, Capt. G. W. Hughes, United States Topographical Engineers, in an inspection report (Doc. No. 50, H. R., War Department, Twenty-seventh Congress, third session), gives a less hopeful account of the improvement. The usual appropriations were made for the years 1842, '43, '44. In 1843, Captain Sanders estimated that it would take $2,000,000 to complete the improvement so as to give a minimum draught of 2 feet between Pittsburgh and Louisville. No further appropriations were made till 1853, when $90,000 was appropriated for the Cumberland dam. This dam well illustrates the difficulty of making a dam across the sandy bed of a river.

Mr. Charles A. Fuller, agent for the Ohio, examined in 1853 the dams previously built and needing repairs, besides localities requiring several additional ones. Wherever they were built on sandy bed, as was the case with those below Louisville, they were in a very dilapidated condition. The Board of Topographical Engineers, Kearney, Long, and Turnbull, in the annual report for 1854, advised the abandonment of

* Transmitted by President Monroe to House of Representatives, January 22, 1823, and printed, without plans, by Gales & Seaton, 1823, as Document No. 35.

all the dams in the parts where the bed is sandy, except the Cumberland dam, and thought the only resource to be dredging at the shoals after every high water. The gap in the Cumberland dam was filled. In 1854, Agent Fuller partially repaired the dams in the Upper Ohio, using 800 tons of stone. I believe no further work was done till 1867, when appropriations were again made and have since been continued.

In 1866, Mr. W. Milnor Roberts commenced an examination and survey of the Ohio, and subsequently prepared a plan for a thorough improvement. We have his final report, printed as H. Ex. Doc. No. 72, Forty-first Congress, third session, dated April 21, 1870—a book of 198 pages. Besides preparing the report, Mr. Roberts had charge of the improvement by dams in 1867, 1868, and 1869.

He says:

> Former reports to the department, made some years ago by different engineers and later by myself, concur in the opinion that the system heretofore adopted, to improve the navigation by means of riprap dams, although beneficent and useful, especially at low-water navigation, does not meet the requirements understood as belonging to the radical improvement of the whole river. * * * All that has been promised or hoped for under this system, without the aid of artificial reservoirs, has been an increase of 12 to 18 inches in the natural river.

Mr. Roberts then gives a very thorough and exhaustive discussion of the other plans of improvement, and concludes that low dams requiring locks of about 6 feet lift furnish the best means of obtaining the desired navigation. He does not consider a continuous canal along the river, because it would not be an improvement of the Ohio; but it may be stated here that it would be a very expensive work on account of the difficulty of crossing the numerous large affluents.

Col. W. E. Merrill, United States Engineers, who has since had charge of the Ohio improvement, substantially agrees with Mr. Roberts as to the necessity for dams and locks, proposing, however, to adopt movable dams instead of fixed ones. This is a method which Colonel Merrill has thoroughly studied as practiced in recent years on some of the rivers of France, and he thinks it well adapted to the Upper Ohio. (See Annual Report of Chief of Engineers for 1874, pp. 406–410.)

Mr. Roberts, I believe, did no work at the Cumberland dam, in which a new break occurred after it was repaired by Agent C. A. Fuller. Colonel Merrill repaired this break only to have a new one occur at a succeeding high water. Such has been the experience in many dams on beds of movable material.

Conclusion with regard to canalization of the Wisconsin.—It seems to me, from what I have presented in this chapter, that no satisfactory improvement on the Wisconsin can be made by any system of contraction or rectification.

It has been shown that it is a kind of improvement that, wherever applied and however successful, requires an amount of time that the present wants of transportation cannot wait for in this case; that it has never succeeded to any extent in this country nor in any other where the river's slope was as great as 18 inches per mile, the most favorable case being that of the Garonne River, in the south of France, having this slope, but whose navigation is suspended at low water; that works of contraction in the sandy bed of the Ohio River have been tried and given up by successive engineers; and, lastly, that the attempt to give requisite stability to such sandy beds, tried in India under the most favorable circumstances of engineering skill and abundant and cheap labor, has been pronounced impracticable.

IMPROVEMENT BY MEANS OF RESERVOIRS AT THE SOURCES.

A project of this kind was suggested by Mr. C. D. Westbrook, jr., in his report to the Fox and Wisconsin Improvement Company, in December, 1854. He says:

> That remedy is the location of a dam upon the upper waters of the Wisconsin, where the public lands have not as yet been brought into market, that will create a reservoir in which a sufficient quantity may be stored from the high water in the spring of the year, to maintain an equable supply throughout the dry season sufficient for the uninterrupted navigation of the stream. Assuming this extra supply to average 100,000 cubic feet per minute (1,666 cubic feet per second), a dam 20 feet in height, flowing 100 square miles, would be sufficient. The cost of such a structure, in comparison with its results, would be too insignificant to require an estimate of its probable amount, until it is determined by actual survey.

Mr. Westbrook assumes—

> That a sufficient supply of water for steamboat-navigation is had in this stream, except from the middle of August to the latter part of October, when, in common with all western rivers, so many interruptions exist, precisely at the period when their services are most needed, that they fail to meet the wants of the growing West, and are superseded to a considerable extent by railroad transportation.

Allowing the period Mr. Westbrook provides for to be 75 days, it would take 10,800,000,000 cubic feet.

Doubtful possibility of success.—The data obtained from our survey in 1867 enable us to deal with this question with more definiteness. If good navigation is to be made on this river, it must be by some plan which shall not fail in ordinary low-water years at least, and so we may take the year 1867, which was observed, as a test case. The available depth at low water of that year was certainly not greater than 1½ feet. There were 93 days that year when the water was between low water and 1 foot above; 58 days when it was between 1 foot and 2 feet above low water; and 30 days when it was between 2 and 3 feet above low water. Allowing that each foot of rise would give us an additional foot of navigable depth (too favorable a supposition), and supposing that during the periods just named only half the quantity which we have determined to be necessary to raise the natural river each foot on the gauge would be required after a partial rectification (also a favorable supposition), we see that at Skinner's Bluff, according to the table in Chapter IV of volumes, at all stages at Skinner's Bluff, we would require—

5,850 cubic feet per second for 93 days;
3,130 cubic feet per second for 58 days;
1,130 cubic feet per second for 30 days;

or a total amount at Skinner's Bluff, to secure 4½ feet draught on the most favorable supposition, of 65,619,936,000 cubic feet. But if the natural river were improved in this manner, we should be compelled to supply double the above amount near the mouth.

Immense cost.—The reservoir capacity, then, would have to be about twelve times greater than that estimated by Mr. Westbrook. If such reservoir is not absolutely impossible, it must be nearly so, and it is a sufficient estimate of what it would cost to state that it more than ninety-nine times exceeds the storage capacity of the water-works for supplying New York City.

Great danger attending such works.—It seems unnecessary to discuss further the project of keeping up navigation in the natural river by means of reservoirs, to retain the water in seasons of surplus, and distribute it to supply deficiencies in dry seasons. If the plan of making a thoroughly regulated or rectified river could be shown to be practicable,

there would be much less volume required to raise it during low stages, and it might be well enough to consider the question of reservoirs in connection with that method. But if any other method can be designed, it will be advisable not to adopt the plan of reservoirs with their land-damages, their costly construction, maintenance, and use, and the ever-to be endured dread of destruction by the giving way of the dams and the deluging of the valley below.

METHOD OF IMPROVEMENT BY DAMS AND LOCKS.

Difficult and expensive, if not impracticable.—The difficulty of constructing dams in the bed of such a sandy river is very great. The scour on the lower side would probably remove the sand down to the bed-rock, and the construction of cribs filled with stone and well protected by riprap reaching down to the rock would then be necessary to give permanence. Such dams were built across the sandy bed of the Upper Wabash River in Indiana, and it was found that after giving way once or twice, the third construction would generally stand, because the *débris* of the first two dams filling into the place scoured out below them made a foundation and an apron for the dam reaching down to the bed-rock.

Where experience has shown that dams could be built on sandy beds, they have been constructed only at a great expense. There is almost a certainty that the space above the dam will fill up with sand to the level of the top, so that the pools in low water could not be navigated.

These dams on the Wisconsin would have to be frequent on account of the slope of the river, being 1½ feet to the mile, so that, with locks lifting 7 feet, they would probably be as near as every 5 miles, 23 of them being thus required. This number, with their very considerable lengths across the overflowed valley, would make them very expensive, even if good foundations existed. Finally, we must take into the account that such works will be exposed to all the power of extraordinary floods.

Never recommended, and special data not obtained for depth to bed-rock.—I have never known any one to recommend locks and dams for the Wisconsin below Portage, and I have not thought it worth while to try to present an estimate of the cost of such improvement or of the time required to build it. Special location of the dams and borings to the bed-rock must precede any reliable attempt at an estimate. My limited means would not allow of my making these, even if I had thought that such a plan had any probable feasibility, and I think it has not.

IMPROVEMENT OF NAVIGATION BY MEANS OF CANAL ALONG THE VALLEY.

Data for making location.—When the survey was made in 1867, the object was to get a good hydrographical and topographical knowledge of the course of the stream, with a view to planning works of improvement in the bed of the river. The impossibility of doing anything with our dredge or scraper boat was pretty well demonstrated in that year, and the results of the survey soon made plain the great difficulty of improving the river by canalization or any of the other methods treated of in the preceding parts of this chapter. Therefore, in 1868, I directed examinations to be continued, so as to obtain a more definite idea of the margins of the flood-plain, of the heights of the terraces, &c., with a view to a survey for locating a canal and preparing estimates. In 1869 I

made a reconnaissance of the valley, assisted by Mr. Jacob Blickensderfer, jr., a distinguished civil engineer, and one well versed in canal-construction. The funds at my command did not admit of making a thorough survey for canal-line, so we made as good a location on our maps as the information we had allowed, and constructed an approximate profile of this line from which to estimate the amount of excavation and embankment. This profile was made by means of the level-notes of the survey of 1867, which gave the river-slope and bottom-lands and the heights of the terraces generally. We also had the profile of the railroad along the bank. The uniform character of the valley enabled us to make this profile with some degree of reliability.

Provisional location.—The location proposed for the canal is shown on the small general map. This map also shows a profile of the route with the proposed positions of the locks, and in order to make it serve as a general map for considering the entire route from the Mississippi to Green Bay, it is made to embrace the whole extent.

The simple outline of the location estimated on is as follows: First, to continue the Portage Canal down to the mouth of the Baraboo River; second, to improve the river at this point so as to enable us to lock into it on the left bank, cross it, and lock out again on the right bank; third, the location to continue along the right bank, keeping up as high as practicable along the side of the valley so as to reach the Sauk Prairie; fourth, to continue the canal on the right side of the valley, locking down to low-water level after leaving Sauk Prairie, so as to get a new feed-supply as far as Pine River; fifth, in order to avoid an expensive aqueduct across Pine River, to improve the Wisconsin there, lock into it, cross to the other side, and lock out again; sixth, to continue down the left bank until the mouth of Green River be reached; seventh, to improve the Wisconsin between this and the mouth of the Kickapoo—distance of about 3 miles—and cross back to the right bank just below the mouth of the Kickapoo; eighth, the canal to continue on the right bank and lock into the Mississippi at Prairie du Chien. These crossings of the river are for the purpose of avoiding costly aqueducts over affluents, and to make the feed-supply for the canal ample and easily obtained.

Objectionable features and alternatives to avoid them.—The objectionable features of this location are the difficulties that may attend the satisfactory improvement of the river-crossing, and the trouble that river-sand at those points may give at the head and tail bays of the locks.

It may be necessary to keep out of the river entirely, and this may be done by continuing the Portage Canal on the left bank down to Merrimac or Skinner's Bluff, or until a sufficient elevation is gained above the Wisconsin to build an aqueduct across it; after this, to continue all the way on the right bank, keeping high enough to pass all the affluents by aqueducts. With this arrangement the feed supply becomes more difficult. The whole matter must be thoroughly gone over again, location surveys and comparative estimates being made, before the best plan for a canal can be named.

Prairie du Chien is the natural terminus for a canal, on account of its large and deep harbor. This is the result of the influence of the sands brought into the Mississippi by the Wisconsin River about 4 miles below. The Mississippi water is thus, as it were, held back by a dam, so that for many miles above the river has the features of a lake. The reverse conditions obtain below the mouth of the Wisconsin, where for many miles the Mississippi is made very shoal and rapid by the sands from this tributary.

CHARACTER OF CANAL AND LOCKS.

I submit the following approximate estimate on the first location named above. The canal is to be provided for steamboat-navigation, to be paved or otherwise protected, and to be fully 4 feet deep at low water and 100 feet wide at the narrowest places, with locks 165 feet long and 35 feet wide.

The location selected for this canal, and on which this estimate is based, is that which would make the cost of construction the least, and the proportions of the canal are only such as would make it certainly as good a line as that already constructed from Lake Winnebago to Green Bay, and better than there is any prospect of obtaining from improvements in the bed of the river.

It is well enough to say here that the improvement should eventually be much better than this, but as a preliminary estimate it is thought sufficient to only go thus far. A thorough improvement requires the reconstruction of the works on the Upper and Lower Fox Rivers.

Description of locks, with general direction as to construction.—The lock designed is known as the "composite lock," and is constructed of stone, timber, plank, boards, and iron. The chamber is to be 165 feet long between the gates, and 35 feet wide at the bottom. The sides are to extend 27 feet, including the breast above the upper hollow quoins, and 20 feet, including the return-walls below the lower hollow quoins.

The head is to be an L of hydraulic masonry, carried back 12 feet, and to be further protected by a slope and protection wall. The foot of the lock is to have an apron, and the bottom and sides of the canal are to be paved for 100 feet below.

The foundation, except at the miter-sill, is to be of pine, 10 inches in depth by 12 inches wide, of sufficient length to extend at least 1 foot beyond the walls of the lock; to be laid so as to cover two-thirds of the surface, and the space between the timbers to be puddled. The timbers under the lower miter-sill are to be of white oak, and to cover the whole surface for a space of 8 feet. The foundation-timbers are to extend at least 1 foot above the breast-wall and 25 feet below the return-walls, for an apron.

There should in all cases be four rows of sheet-piling extending across the foundation, one at each end and one under each miter-sill; to be of 2-inch pine plank, and to extend from 4 to 6 feet below the surface of the foundation, and to be lined with inch pine boards—the whole to be properly secured to the foundation-timbers. Ditches are to be excavated to receive the piling, and, when placed and fastened, the space on both sides is to be carefully puddled so as to render the work impervious to water.

The whole foundation is to be covered with pine plank 2½ inches thick; that part of the foundation between the side walls of the lock, extending from the breast down to the return-walls, except under the miter-sills, is to be lined with 2-inch pine plank, in such a manner as to make a water-tight floor.

Cross-sills of sufficient length to extend into the walls at least 3 inches are to be laid across the floor, and fastened to the foundation-timbers with screw-bolts, V-thread. Of these, fourteen in the chamber and two immediately below the lower gates are to be of white oak, 9 inches deep and 10 inches wide. On the apron are to be two sills of pine, 9 inches deep and 12 inches wide.

The side walls are to be rubble masonry, laid up dry, except 4 feet square about each hollow-quoin post, which is to be laid in hydraulic

cement; the side walls are to be 11 feet wide at the bottom, including the front sill, and are to be carried up on the inside with a batter of one-fourth of an inch to the foot, and on the back or outside with such a batter in offsets as will give 6 feet width at the top. The breast-wall and head-wings are to be laid in hydraulic cement, the height, width, &c., to be determined by the lift of the lock and location.

The necessary sills, girts, and posts are to be placed in front of the chamber and recess walls, to receive the plank and boards requisite to make the lock water-tight; the sills to be bolted to the foundation, and the posts anchored into the wall.

The quoin-posts are to be inserted in the wall, and securely anchored to the same.

The chamber is to be lined with two courses of pine plank, the first to be 2-inch, placed longitudinally, and properly fastened to the posts. The second course, of 1½-inch plank, is to be placed vertically in front of the first course of planking, and secured to copings, girts, and sills.

The coping is to be of white oak, not less than 9 inches thick and 15 inches wide. It is to receive the head of the chamber and quoin-posts, and to be connected by anchor-timbers to a longitudinal timber on the outside of the lock-wall.

The frames of the gates are to be of white-oak timber; the bars and posts to be bound together by wrought-iron straps and balance rods, the lower ends of the heel-posts to be banded with wrought-iron bands, and the posts to rest and turn upon pivots and sockets of the best cast iron.

Fender-cribs 16 feet long and 8 feet wide are to be placed at the head of each lock, in such a position as to form an entrance to and a protection for the lock.

Estimate has been made for building thirteen weirs, in connection with the locks, for passing feed-water from one level to the next below. In locks with weir-connections the lower return-wall is to be continued 14 feet beyond the usual length. From this point it will slope up and down the canal, making a retaining-wall for the bank of the weir. A sluice-way is to be made in the lower return-wall, the bottom to be 3 feet below the surface of the water in the upper level, and 12 feet in width. In addition to the increased length of the return-wall, there will be timber for foundation, sheet-piling, hydraulic masonry, embankment, &c. The cost of these feed-weirs is not included in the cost of the lock, but is given separately in the detailed estimates.

A puddle-wall of suitable material, 10 feet wide and 55 feet long, transversely of the canal, shall be carried up from the foundation to the surface immediately in front of the breast, in addition to the puddling around the sheet-piling and between the foundation-timbers.

An estimate for the excavation of the lock-pit has been made in the case of each lock, at the rate of 30 cents per cubic yard when above water, and $1.25 when under water. The embankment is included in the total for canal-embankment.

BILL OF LOCK-MATERIALS.

Bill of lumber for a composite lock 165 *feet long*, 35 *feet wide, and of* 8 *feet lift.*

No. of pieces.	Where used.	Length, feet.	Width, inches.	Depth, inches.	Cubic feet. Pine.	Cubic feet. Oak.	Board measure. Pine.	Board measure. Oak.
	Foundation.							
39	Upper and lower recesses, breast and below gates	64	10	12	2,080	......	......	......
18	Under miter-sills	64	10	12	......	960	......	......
112	In chamber	60	10	12	5,600	......	......	......
2	Miter-sills	40	16	12	......	106⅔	......	......
4	......do	20	16	12	......	106⅔	......	......
2	......do	7½	18	12	......	22½	......	......
18	Under lower return-walls	12	10	12	180	......	......	......
21	Cross-floor timbers	36	10	8	420	......	......	......
	Floor, first course of foundation	....	2½	....	......	......	32,350	......
	second course of foundation	....	2	....	......	......	14,164	......
	Sheet-piling, four courses	....	2	....	......	......	3,072	......
	......do	....	1	....	......	......	1,536	......
					8,280	1,196	51,122	......
	Chambers, recesses, &c.							
12	Oak sills and girts in recesses	24	14	10	......	280	......	......
30	Oak sills and girts in chamber	30	14	10	......	875	......	......
4	Oak coping in recesses	29	18	9	......	131	......	......
10	Oak coping in chamber	30	15	9	......	281	......	......
2	Oak coping below lower recess	20	20	9	......	50	......	......
2	Oak coping return-walls	24	20	9	......	60	......	......
6	Oak anchor-timbers	24	10	8	......	80	......	......
10	......do	29	10	8	......	161	......	......
21	......do	18	10	8	......	210	......	......
98	Oak posts in chamber and recesses	5	10	8	......	272	......	......
196	......do	5½	10	8	......	599	......	......
2	Oak posts in corner of upper recess	17	12	12	......	34	......	......
2	Oak posts in corner of lower recess	17	20	10	......	47	......	......
4	Oak posts for hollow quoins	17	6	9	......	26	......	......
4	......do	17	13	13	......	80	......	......
4	......do	17	13	15	......	92	......	......
4	Oak blocks on top of gates	4½	18	24	......	54	......	......
					......	3,332	......	......
	Gates.							
4	Oak miter-posts	19	14	14	......	103	......	......
4	Oak quoins	19	14	16	......	119	......	......
8	Oak arms at top and over paddles	20	10	14	......	156	......	......
4	Oak arms at bottom	20	12	14	......	93	......	......
28	Oak arms	20	8	12	......	373	......	......
16	Oak paddle-studs	4	15	14	......	93	......	......
4	Oak spars to shut gates	28	8	8	......	50	......	......
					......	987	......	......
	Planking.							
	Chamber, first course	181	2	....	......	......	12,302	......
	second course	....	1½	....	......	......	9,231	......
	On gates	....	2	....	......	......	2,000	......
	Oak fender-planks, upper gates	12	2	....	......	......	......	288
	Oak tongues	...	½	....	......	......	......	150
6	Oak ties	8	5	8	......	......	......	160
60	......do	6	5	8	......	......	......	1,200
					......	......	23,539	1,798

RECAPITULATION.

Foundation	8,280	1,196	51,122	......
Chambers, recesses, &c	......	3,332	......	......
Gates	......	987	......	......
Planking	......	......	23,539	1,798
	8,280	5,515	74,661	1,798

Bill of iron for a composite lock 165 *feet long*, 35 *feet wide, and of* 8 *feet lift.*

No. of pieces.		Length, inches.	Width, inches.	Thickness, inches.	Pounds.
	Wrought iron.				
40	Round sill-bolts	20	1⅛	......	222
24	Round miter-sill screw-bolts, V-thread	20	1½	......	237
8	Round hollow-quoin bolts	84	1¼	......	231
8	Flat anchors to same	20	2	½	44
72	Round chamber and recess bolts	72	1¼	......	1,780
72	Flat anchors to same	20	2	½	403
4	Flat heel-post bands	50	2	½	56
40	Flat heel-post straps	98	2½	½	1,372
40	Flat miter-post straps	74	2½	½	1,036
160	Round bolts to same	15	¾	......	296
8	Flat diagonal braces	288	3	⅝	1,210
8	Round tops of same	28	1¼	......	78
20	Round swivel-screws	60	1¼	......	410
12	Round braces to blocks	144	1¼	......	593
12	Flat anchors to same	72	3	½	365
4	Round journals in top of quoin-posts	12	3	......	94
16	Round pins on top of blocks	6	1¼	......	33
4	Flat collars in blocks	16	3	¼	40
4	......do	14	3	¼	35
8	Round bolts to same	20	¾	......	20
12	Square bars to paddles	168	1	1	564
168	Nuts ¾-inch bore	2¼	2¼	¾	163
8	Square plates in blocks	1¼	1¼	¼	260
168	Washers	2	2¼	1⅛	15
72	......do	......	......	......	11
					9,568
	Cast iron				
	Paddle-gates, &c	......	......	......	9,012
	Spikes and nails	......	......	......	2,000
					11,012

Estimated cost of a lock.

Estimated cost of a lock 165 *feet long*, 35 *feet wide, with* 8 *feet lift.*

Pine, 74.661 feet, board-measure, at $22	$1,642 54
Oak, 1,798 feet, board-measure, at $32	57 54
Pine, 8,280 cubic feet, at 20 cents	1,656 00
Oak, 5,515 cubic feet, at 30 cents	1,654 50
Dry wall, 2,192 cubic yards, at $8	17,536 00
Hydraulic wall, 313 cubic yards, at $15	4,695 00
Puddling, 400 cubic yards, at 50 cents	200 00
Wrought iron, 9,568 pounds, at 15 cents	1,435 20
Cast iron, 9,012 pounds, at 8 cents	720 96
Spikes and nails, 2,000 pounds, at 6 cents	120 00
Snubbing-posts, 6, at $5	30 00
Capstans and spars, 4, at $20	80 00
Painting gates	30 00
Timber fender-cribs	564 00
Total	30,421 74

This should be increased for locks located where the foundation is insecure, as follows:

Piles for foundation and protection, 474, at $5	2,370 00
Bolts for fastening foundation to piles, 471 pounds, at 15 cents	70 65
Total cost of lock	32,862 39

The details of the estimate for each proposed lock are given in the appendix to this report.

Summary of the cost of all the lift-locks.

Number of lock.	Lift.	Cost.	Number of lock.	Lift.	Cost.
	Feet.			*Feet.*	
Lock No. 1	9	$39, 836 38	Lock No. 13	$8\frac{3}{10}$	$32, 565 61
Lock No. 2	8	31, 431 79	Lock No. 14	9	32, 689 48
Lock No. 3	8	31, 087 99	Lock No. 15	9	32, 526 93
Lock No. 4	8	32, 520 49	Lock No. 16	8	33, 096 79
Lock No. 5	7	31, 746 43	Lock No. 17	8	33, 096 79
Lock No. 6	8	32, 143 59	Lock No. 18	7	31, 745 18
Lock No. 7	7	32, 546 43	Lock No. 19	7	30, 980 18
Lock No. 8	8	31, 929 54	Lock No. 20	9	34, 744 48
Lock No. 9	8	31, 929 54	Lock No. 21	*9½	40, 183 70
Lock No. 10	8½	32, 765 61			
Lock No. 11	9	33, 531 03	Total	....	701, 219 19
Lock No. 12	9	38, 121 23			

Summary of cost of all the guard-locks.

Guard-lock No. 1	$37, 132 04
Guard-lock No. 2	36, 882 04
Guard-lock No. 3	36, 882 04
	110, 896 12

Cost of feed weir connected with lock.

For continuation of lower return-wall of lock, 153 cubic yards of hydraulic masonry, at $10 per yard	$1, 530 00
128 cubic yards of dry masonry, to be made hydraulic at an increased cost of $5 per yard	640 00
Timber, 5,500 feet, board-measure, at $25	137 50
Puddling, 38 cubic yards, at 50 cents	19 00
Spikes	3 00
Planking, 1,385 feet, board-measure, at $20	27 70
Sheet-piling, 320 feet, board-measure, at $20	6 40
Embankment, 1,910 cubic yards, at 30 cents	573 00
	2, 936 60

Cost of feed pipes about one mile below Honey Creek.

Two cast-iron pipes 60 feet long, 36 inches inside diameter, and 3 inches thick, with two stand-pipes 6 inches in diameter, and 15 feet long; in all, 49,797 pounds, at 8 cents	$3, 983 76
2 gate-stems, wrenches, &c., 450 pounds, at 15 cents	67 50
2,688 pounds cast-iron in gates, at 8 cents	215 04
500 feet, board-measure, sheet-piling, at $20	10 00
Bedding timber and watch-house	100 00
	4, 376 30

Cost of culverts.—Estimates have been made to pass Honey Creek, Blue River, and Grand Gris Creek under the canal with culverts. In determining the amount of water-way requisite to pass these streams we have used the following rules:

1. For every mile in length give 2 feet span.
2. For every square mile drained give 1 foot area in opening.

At Honey Creek we have allowed more space than either rule calls for, because when the Wisconsin River is high the culvert will be submerged and the flow of water in the creek obstructed. We have estimated for two semicircular arches of 28 feet span each; these arches are to rest on two rows of piling. The wing-walls are to be 24 feet long, making an angle of 120° with the face of the culvert, and to be built on piling also. Over the arches a parapet, or retaining-wall, 3 feet high, is to be constructed. The material between the crown of the arches and the bottom of the canal is to be well packed and puddled.

Bill of timber, masonry, &c., for Honey Creek culvert:

Piles under arches and wings, 836, at $5	$4,180 00
Pine timber under arches, 1,312 cubic feet, Pine timber under wings, 480 cubic feet, } 1,792 feet, at 20 cents	358 40
Plank under arches, 1,804 feet, Plank under wings, 720 feet, } 5,048 feet, board-measure, at $20	100 96
Iron bolts, 3′ × 1″ with nuts, 68, 750 pounds, at 15 cents	112 50
Hydraulic masonry:	
In arches, 1,151.4 cubic yards, In wings, 298.5 cubic yards, In parapet, 183.0 cubic yards, } 1,633 cubic yards, at $15	24,495 00
Puddling, 1,932 cubic yards, at 50 cents	966 00
Riprap, 163 cubic yards, at $1.50	144 50
Pit excavation under water, 9,081 cubic yards, at $1.25	11,351 25
	41,808 61

For the Blue River we have estimated for two semicircular arches of 20 feet span, the arches to rest on a timber foundation covered with plank. To prevent scour a row of sheet-piling is to be placed at each end of the foundation, and the bed of the creek is to be riprapped.

Bill of timber, masonry, &c., for Blue River culvert:

Timber in foundation, 3,816 cubic feet, at 30 cents	$1,144 80
Plank, 11,550 feet, board-measure, at $20	231 00
Sheet-piling, 1,200 feet, board-measure, at $20	24 00
Riprap, 50 cubic yards, at $1.50	75 00
Spikes, 550 pounds, at 5 cents	27 50
Excavation, 2,935 cubic yards, at $1	2,935 00
Puddling, 1,044 cubic yards, at 50 cents	522 00
Masonry, 598.3 cubic yards, at $15	8,974 50
	13,933 80

For Grand Gris Creek a semicircular arch of 10 feet span is estimated for.

Bill of timber, masonry, &c., for Grand Gris Creek culvert:

Timber in foundation, 2,059 cubic feet, at 30 cents	$617 70
Plank, 6,176 feet, board-measure, at $20	123 52
Sheet-piling, 1,040 feet, board-measure, at $20	20 80
Spikes, 390 pounds, at 5 cents	19 50
Excavation, 1,875 cubic yards, at $1	1,875 00
Puddling, 630 cubic yards, at 50 cents	315 00
Riprap, 30 cubic yards, at $1.50	45 00
Masonry, 227.3 cubic yards, at $15	3,409 50
	6,426 02

Cost of waste-weirs.—Estimate for eighteen waste-weirs has been made; this allows one to every level of any considerable length. This appears to be a liberal estimate for a canal of this length, but the fact of the greater part of the canal being located at the foot of bluffs makes it necessary to provide for a large amount of surface-drainage. The cost of these weirs depends so much upon location that we have allowed for an equal number of each of two kinds, an estimate for one of each being given.

Bill of materials for a waste-weir to consist of a center-crib 100 feet long and 7 feet high, with two wings 10 feet long and 10 feet high:

Pine timber (10″ × 10″) in foundation, 1,010 cubic feet, at 20 cents	$202 00
Sheet-piling, 1,200 feet, board-measure, at $22	26 40
Pine timber in center crib (12″ × 12″) 1,120 cubic feet, at 20 cents	224 00
Pine timber in end cribs (22″ × 12″) 1,200 cubic feet, at 20 cents	240 00
Plank to cover center and apron, 3,200 feet, board-measure, at $22	70 40

Spikes, 5-inch, 135 pounds, at 6 cents	$8 10
Stone to fill cribs, 215 cubic yards, at $1.50	322 50
Riprap to protect bank at end of apron and about ends of weir. 100 cubic yards, at $1.50	150 00
	1,243 40

Bill of materials for a waste-weir, to consist of a single timber 100 feet long, with two wings 10 feet long:

Pine timber (12″ × 12″), 100 cubic feet, at 20 cents	$20 00
Pine timber, (12″ × 12″), for wings, 20 cubic feet, at 20 cents	4 00
Sheet-piling 1,000 feet, board-measure, at $22	22 00
Spikes, 50 pounds, at 6 cents	3 00
Riprap, 94 cubic yards, at $1.50	141 00
	190 00
Total cost for eighteen weirs, nine of each kind	12,900 60

Cost of bridges.—We have estimated for twenty highway-crossings—though it is probable that a less number will accommodate the public when the canal is built—and one railway-crossing.

Estimated cost:

20 highway-bridges, at $1,400	$28,000 00
Embankment for approaches	1,921 25
1 railway swing-bridge	2,500 00
	32,421 25

Cost of walling.—We have provided for walling or paving the inner slope (if artificial) of the canal in all cases where the width is less than 200 feet, from 4 feet below to 2 feet above the water's surface.

Estimated cost $192,210 00

Cost of riprap.—The outer slope, the slope next to the river, is to be riprapped from the bottom to above high water in all cases where the canal is located along the bank of the river.

Estimated cost $201,264 00

Cost of grubbing.—We have allowed for 383½ acres to be grubbed, at $75 per acre.

Estimated cost $28,762 50

Cost of clearing.—There would be about 1,446 acres of clearing, estimated to cost $25 per acre.

Estimated cost $36,150 00

Cost of engineering, the work to be done in two years.—The entire improvement can be made in two years, and the engineering expenses will be as follows:

For one chief engineer, at $600 per month	$14,400 00
For 2 assistants to chief engineer, at $200 per month each	9,600 00
For 1 engineer, 1 rodman, and 1 axman, on each of ten divisions into which the line will be divided, $250 per month for each division	60,000 00
For 1 engineer and 1 rodman, one year, on each of the 24 locks, at $200 per month	57,600 00
For 1 clerk and 2 draughtsmen, at $150 per month each, for office	10,800 00
For rent of office, fuel, and attendance, 2 years	4,000 00
For paper, drawing-material, &c	2,000 00
For 24 leveling and 10 transit instruments, with target-rods and chains, at $160 each	5,440 00
For traveling and incidental expenses	10,000 00
	173,840 00

There will be constant employment in the canal for one dredge-boat, scows, and tug.

Estimated cost $25,000 00

GRAND TOTAL COST.

Summary of estimate for canal, 86 feet least width at bottom, and 4 feet draught, with locks 165 feet by 35 feet, clear for boats:

Embankment	$1,200,564 95
Excavation	737,279 70
21 lift-locks	701,219 19
3 guard-locks	110,896 12
Feed-weirs	38,175,80
Feed-pipes	4,376 30
Culverts	62,168 43
Waste-weirs	12,900 60
Bridges	32,421 25
Walling	192,210 00
Riprap	291,264 00
Grubbing	28,762 50
Clearing	36,150 00
	3,448,388 84
Engineering	173,840 00
Dredge-boat, and scows and tug	25,000 00
Contingencies	352,771 16
	4,000,000 00

Additional cost for 5 feet draught.—The miter-sills have been so placed in the foregoing plan and estimate as to have 5 feet draught over them, so that the canal might be made to allow of 5 feet draught instead of 4, by additional excavation amounting to 550,000 cubic yards, at 30 cents per yard $165,000

Annual expense of superintendence and repairs.—The annual expense of superintendence and care of the work after it was completed would be as follows:

One superintendent	$3,000
Twenty-six lock and feed tenders	17,000
Operating dredge and tug, fuel, laborers, engineers, &c	30 000
	50,000

45TH CONGRESS, 2d Session. } HOUSE OF REPRESENTATIVES. { Ex. Doc. No. 50.

DECREASE OF RECEIPTS FROM INTERNAL REVENUE.

LETTER

FROM

THE SECRETARY OF THE TREASURY,

TRANSMITTING

A communication from the Commissioner of Internal Revenue, showing a decrease of receipts for the current fiscal year.

FEBRUARY 14, 1878.—Referred to the Committee of Ways and Means and ordered to be printed.

TREASURY DEPARTMENT,
February 13, 1878.

SIR: I have the honor to inclose herewith a copy of a communication this day received from the Commissioner of Internal Revenue, setting out that the internal-revenue receipts for the current fiscal year, including yesterday, as compared with the same period of the last fiscal year, have suffered a decrease of $4,969,218.56, and suggesting as one cause of this decrease the agitation for the reduction of the tax on spirits and tobacco. The attention of Congress is invited to his recommendations.

It becomes my duty in this connection to urge upon Congress, in anticipation of the same decrease occurring during the next fiscal year, a reduction of the appropriations to be made for the service of the government during that year, or an increase of taxation in such form as Congress may deem best.

Very respectfully,

JOHN SHERMAN,
Secretary.

HON. SAMUEL J. RANDALL,
Speaker House of Representatives.

TREASURY DEPARTMENT,
OFFICE OF INTERNAL REVENUE,
Washington, February 12, 1878.

SIR: I take the liberty of calling your attention to the fact that the internal-revenue receipts for the current fiscal year, including this day, as compared with the same period of last fiscal year, have suffered a de-

crease of $4,969,218.56. This decrease commenced in July, as a result of the railroad-strike, and has been greatly aggravated since the meeting of Congress by the agitation of the question of reducing the taxes on spirits and tobacco. I learn from many quarters that the trade in these taxable articles throughout the country is very much paralyzed, and will continue so until the intention of Congress in regard to the reduction of the taxes is definitely made known.

I think there is no probability that the amount thus lost to the revenue will be regained during the balance of the present fiscal year, but, on the contrary, it will probably be largely increased. If Congress should in some decisive way indicate that the taxes on spirits and tobacco as now fixed by law will remain unchanged, I believe the decrease in revenue would be arrested, and the trade would soon recover its former stability. A resolution has passed the House, and will shortly come before the Senate, declaring that a change in the rate of taxation on distilled spirits is inexpedient at the present time. In my opinion, the passage of a similar resolution with regard to the tax on tobacco would be highly beneficial. I respectfully submit whether this question is not one of such great importance to the revenues of the government as to justify your calling the attention of Congress to it.

Very respectfully, your obedient servant,

GREEN B. RAUM,
Commissioner.

Hon. JOHN SHERMAN,
Secretary of the Treasury.

45TH CONGRESS, 2d Session. } HOUSE OF REPRESENTATIVES. { Ex. Doc. No. 52.

SOUTH PASS OF THE MISSISSIPPI RIVER.

LETTER

FROM

THE SECRETARY OF WAR,

TRANSMITTING

A report upon the improvement of the South Pass of the Mississippi River.

FEBRUARY —, 1878.—Referred to the Committee on Commerce and ordered to be printed.

WAR DEPARTMENT,
Washington City, February 13, 1878.

The Secretary of War has the honor to transmit to the United States Senate and the House of Representatives, in compliance with the provisions of paragraph 10 of the fourth section of the river and harbor act of March 3, 1875, the eighth report upon the improvement of the South Pass of the Mississippi River, showing the condition of the works on December 15, 1877, by M. R. Brown, captain of engineers, United States Army.

GEO. W. MCCRARY,
Secretary of War.

The SPEAKER *of the House of Representatives.*

EIGHTH REPORT UPON THE IMPROVEMENT OF THE SOUTH PASS OF THE MISSISSIPPI RIVER, SHOWING THE CONDITION OF THE WORKS ON DECEMBER 15, 1877. BY M. R. BROWN, CAPTAIN OF ENGINEERS, UNITED STATES ARMY.

UNITED STATES ENGINEER'S OFFICE,
Port Eads, La., December 23, 1877.

SIR: I have the honor to present herein a report on the improvement of South Pass, Mississippi River, by works designed by James B. Eads and associates, under the sanction of the act of Congress approved March 3, 1875.

In my last report, dated August 1, 1877, I described the condition of the various structures, of the channel at the head of the pass, and at the sea ends of South Pass, on July 16 and July 24, 1877, respectively.

The present report will advance the history of all the works to November 10, 1877, and of their effects to December 15.

AT THE HEAD OF THE PASSES.

Nothing has been accomplished here since July 16, excepting that the oldest dam, No. 1, rendered nearly or quite superfluous by newer dams, one lower down stream and one above No. 1, has been partly dismantled by the abstraction of the planks and scantling placed there as bracing for the piles.

This material has been taken for fuel on the dredging-machine which has been used in an endeavor to deepen and widen the channel over the bar at the Gulf ends of the jetties. Dam No. 1 extends from the head of the island to the old dike called East Dike.

No great changes have been observed in the channel at the head of the pass. A channel 22 feet deep and 295 feet wide was found here on the 24th of October. On the same day a practicable channel 22½ feet deep existed.

As stated in my last report, a 23-feet channel was found on the 15th of June, 1877.

Neglecting exceptional spots of small area, and generalizing, there has been a scour, varying in amount from 1 to 8 feet, in that portion of the channel below the junction of dam No. 3 and the west T-head, and above the head of the island. Between the upper ends of the two T-heads a fill of from 1 to 6 feet is observed, while between these two areas no noteworthy change has taken place.

On the shoal area east of the channel and west of the southern arm of the east T-head, a scouring action denuding 3 to 4 feet of the bottom has taken place over the upper portion, while lower down on the same shoal from 1 to 4 feet of fill was found.

On the whole, the scour has considerably exceeded the fill, both in the size of the area over which its action has extended, and in cubic yards of material moved.

COMPARISON OF SOUNDINGS IN NORTHEAST AND SOUTHWEST PASSES.

I have included in the survey of the channel at the head of South Pass, and of its vicinity, several lines of soundings made October 20, 1877, in Southwest and Northeast Passes, showing the depths existing just above and below each of the so-called "mattress aprons." A comparison of these soundings with others taken February 28, 1876, indicates that on lines in Southwest Pass, about 250 feet above and 250 feet below the "apron," an average scour of about 0.93 of a foot has occurred in the period, about eight months.

Over a line about 200 feet below the Northeast Pass "mattress apron" a fill of 0.2 foot is found, while about 500 feet lower down in the same pass the average scour on a line running across is 1.13 feet.

These results show that in Southwest Pass no change of consequence has occurred since the last report, and possibly no change has occurred in Northeast Pass.

But in the last survey there were no lines across Northeast Pass as far down stream as 700 feet below the "apron," and the lines run in June, which were compared with those sounded last February, indicated, on the whole, about the same average depths in each case.

The "mattress aprons" remain, so far as is known, in the same condition as at the last report.

THE SOUTH PASS JETTIES.

The work accomplished here, since July 24, has not been great in amount. Four new spurs or wing-dams have been constructed. Two

of the older spurs have received repairs or additions, and in some places a layer of loose willows or stones, or both, has been added to the jetties themselves. The details of the renewals and additions are given in the proper tables and in the following *résumé:*

THE EAST JETTY.

From 300 to 640 feet from East Point about 2 feet of stone have been added, increasing the total thickness of stone here to about 3½ feet.

From 640 to 1,225 feet from East Point a tier of willows, averaging 23 feet wide and 2½ feet thick, has been placed on the jetty. Stone to a depth of 3 to 4 feet along the middle line, but of less depth toward the edges, has been placed on the upper surface of these willows, in a tier about 19 feet wide.

From 1,225 to 2,100 feet from East Point a layer of stone has been added to this jetty. Its depth averages about 3½ feet along the middle line, but it is thinner toward the edges.

From 5,635 to 6,200 feet from East Point a layer of loose willows, 20 feet wide and 2 feet thick, has been placed on the jetty. It is newly covered with stone to a depth of 1 foot.

From 6,200 to 6,400 feet from East Point a layer of stones, about 12 feet wide and 1½ feet in depth, has been placed on the upper tier. No stone had previously been added to this portion of the upper surface of the jetty.

From 7,264 to 7,632 feet from East Point a re-enforcement or buttress of stone has been added, against the sea-edge of the east jetty. The upper surface of this is about 1 foot above average flood-tide. It slopes toward the bottom so that it joins the sea-bed about 10 feet east of the line of guide-piles. The water here, at average flood-tide, was about 2 feet deep generally, but right against the line of piles the water is 2 or 3 feet deeper, not only here, but in many places elsewhere along the jetties. About 600 cubic yards of stone were placed here, varying in weight from 1 to 60 pounds, averaging, perhaps, from 20 to 25 pounds. This work is considered to be tentative. It is doubtless intended to test the utility of the wall in arresting the flow of water through and over the jetties.

From 7,632 feet from East Point station to the end of the east jetty, 11,770 feet from the initial point, no additions have been made, not heretofore reported.

A violent storm, a cyclone, reached the jetties the night of September 17. It lasted three days. During the 18th of September the maximum velocity of the wind was 35 miles an hour. It came then from the west-southwest.

A minimum velocity of wind from the south of 21 miles per hour was noted. On the 19th, a maximum and minimum velocity of 57 and 17 miles per hour respectively was reached on my register. The wind blew from the northwest most of the day. On the 20th, the maximum velocity was 21 miles, minimum 6 miles; direction, from the north and northwest. During the storm the wind veered around from the south-southeast to north, gradually and regularly, and with a near approach to uniformity in the rapidity of change. During the storm, the wind blew at a rate between 17 and 57 miles per hour for 63 hours. During this cyclone a damage of about $1,200 was inflicted on the jetties by loss of stone and the shattering of mattresses.

On September 29, a second violent storm visited the locality. It lasted four days, and the wind blew at a rate of 45 miles per hour, in

the culmination of the hurricane. From 17 to 45 miles per hour were recorded for 77 hours, the wind coming mostly from the east and north-east.

A damage to the jetties and wing-dams of about $3,500 was the result here. The damage to the main jetties in both storms, being consolidated, was as follows:

Between 11,300 feet from East Point and the end of the east jetties 725 linear feet of mattresses were destroyed, of which 545 linear feet were in the top tier, and 180 feet in the next lower layer.

From 8,000 to 11,300 feet from East Point the sea-edge of the upper tier of mattresses was demolished through several short distances, aggregating about 480 feet. The contents of mattresses destroyed here are equivalent to about 150 linear feet.

From 8,930 to 8,990 feet from East Point the upper tier was destroyed. This gap has since been replaced by loose willows covered with stone. About 615 cubic yards of stone were knocked off the jetties by the violence of the waves, in both storms. The aggregate damage amounts to about $4,700.

EAST JETTY.

A tabulated statement of its condition on November 10, and of the progress made in building it from July 24 to November 10, 1877.

Distance from East Point, in feet.	Length of section considered, in feet.	Number of tiers in place July 24.	Number of tiers broken since.	Number of tiers built from July 24 to November 10.	Average width of tiers built since July 24, in feet.	Average thickness of tiers built since July 24, in feet. Sea side.	Average thickness of tiers built since July 24, in feet. River side.	Number of linear feet built since July 24.	Number of cords of willow placed since July 24.	Average elevation, in feet, of upper surface of top tier of mattresses, with reference to the plane of average flood-tide. Sea side.	Average elevation, in feet, of upper surface of top tier of mattresses, with reference to the plane of average flood-tide. River side.	Average thickness, in feet, of stone on upper tier.
60– 160	100	2*	....	....	......	......	......	......	......	0.0	0.0	1 foot.
60†	......									......	......	
160– 350	190	4	....	....	......	......	......	......	......	0.0	0.0	2 feet in middle; thinner at sides.
350– 400	50	3 + willows	....	....	......	......	......	......	......	−0.3	−0.3	3 feet in middle; thinner at sides.
400– 470	70	4	....	....	......	......	......	......	......	0.0	0.0	Do.
470– 570	100	3	....	....	......	......	......	......	......	0.0	0.0	2½ feet in middle; thinner at sides.
570– 640	70	4	....	....	......	......	......	......	......	0.0	0.0	3 feet in middle; thinner at sides.
640– 800	160	4 + loose willows	....	1 of loose willows	23	2½	2½	160	72	+0.5	+0.5	2½ feet in middle; thinner at sides.
800– 960	160	4 + willows	....	do	23	2½	2½	160	72	0.0	0.0	1.6 feet in middle; thinner at sides.
960– 1,080	120	2 and 3 + 2 of willows	....	do	23	2½	2½	120	54	0.0	0.0	1½ feet in middle; thinner at sides.
1,080– 1,080	100	3 + willows	....	do	23	2½	2½	100	45	−0.5	0.0	3 feet in middle; thinner at sides.
1,180– 1,225	45	3 + 2 of willows	....	do	23	2½	2½	45	20	+0.5	+0.5	2 feet in middle; thinner at sides.
1,225– 1,620	395	2 and 3 + loose willows	....	....	......	......	......	......	......	+ .05	+ .05	3½ feet in middle; thinner at sides.
1,620– 1,700	80	3	....	....	......	......	......	......	......	0.0	0.0	4½ feet in middle; thinner at sides.
1,700– 2,100	400	3 + loose willows	....	....	......	......	......	......	......	+ .05	+ .05	2.5 feet in middle; thinner at sides.
2,100– 4,695	2,595	2–5‡	....	....	......	......	......	......	......	−1.0	−1.5	None.
4,695– 4,870	175	3	....	....	......	......	......	......	......	−1.6	−1.6	Do.
4,870– 5,015	145	3 §	....	....	......	......	......	......	......	−1.0	−1.0	Do.
5,015– 5,175	160	4	....	....	......	......	......	......	......	−0.8	−0.8	Do.
5,175– 5,635	460	2–4 ‖	....	....	......	......	......	......	......	−0.6	−0.6	Do.
5,635– 6,200	565	4 + 1 of willows	....	1 of loose willows	20	2	2	565	177	+1.0	+1.0	1½ feet.
6,200– 6,400	200	4	....	....	......	......	......	......	......	+1.0	+1.0	1 foot.
6,400– 8,600	2,200	4	....	....	......	......	......	......	......	+1.0	+1.0	Do.
8,600– 8,720	120	5	....	....	......	......	......	......	......	+1.5	+1.5	Do.
8,720– 8,930	210	6	....	....	......	......	......	......	......	+1.0	+1.2	Do.
8,930– 8,990	60	5 + 1 of willows	1	1 of loose willows	20	2	2	60	19	+0.8	+0.7	1½ feet in middle; thinner at sides.

*Including one of loose willows.
† A layer of willows 30 feet long, making an angle of 70° with up-stream prolongation of jetty. Stone on it 1 foot above average flood-tide.
‡ Nothing done since March 16, 1877.
§ No change since August, 1877.
‖ Nothing done since March 16, 1877.

EAST JETTY.—*A tabulated statement of its condition on November 10, and of the progress made in building it, &c.*—Continued.

Distance from East Point, in feet.	Length of section considered, in feet.	Number of tiers in place July 24.	Number of tiers broken since.	Number of tiers built from July 24 to November 10.	Average width of tiers built since July 24, in feet.	Average thickness of tiers built since July 24, in feet. Sea side.	Average thickness of tiers built since July 24, in feet. River side.	Number of linear feet built since July 24.	Number of cords of willow placed since July 24.	Average elevation, in feet, of upper surface of top tier of mattresses, with reference to the plane of average flood-tide. Sea side.	Average elevation, in feet, of upper surface of top tier of mattresses, with reference to the plane of average flood-tide. River side.	Average thickness, in feet, of stone on upper tier.
8,990– 9,255	265	6	.....	.....	.....	.....	.....	.....	.....	+0.8	−0.1	1 foot.
9,255– 9,300	45	6	.....	.....	.....	.....	.....	.....	.....	−0.9	+0.4	Do.
9,300– 9,400	100	6	.....	.....	.....	.....	.....	.....	.....	+0.4	+0.1	Do.
9,400– 9,500	100	5	.....	.....	.....	.....	.....	.....	.....	+1.0	+0.4	Do.
9,500– 9,700	200	5	.....	.....	.....	.....	.....	.....	.....	+0.5	+0.9	1½ feet.
9,700– 9,740	40	6	.....	.....	.....	.....	.....	.....	.....	+0.5	+0.9	Do.
9,740–10,090	350	5	.....	.....	.....	.....	.....	.....	.....	+0.5	+0.7	Do.
10,090–10,960	870	6	.....	.....	.....	.....	.....	.....	.....	+0.4	+0.3	Do.
10,960–11,160	200	7	.....	.....	.....	.....	.....	.....	.....	+1.3	+1.1	Do.
11,160–11,300	140	7 and 10	.....	.....	.....	.....	.....	.....	.....	0.0	0 0	Do.
11,300–11,400	100	8 and 9	1	.....	.....	.....	.....	.....	.....	(*)	(*)	Very little stone left.
11,400–11,550	150	7 and 8	2	.....	.....	.....	.....	.....	.....	(*)	(*)	Do.
11,550–11,575	25	8 and 9	1	.....	.....	.....	.....	.....	.....	(*)	(*)	Do.
11,575–11,650	75	9 and 10	.....	.....	.....	.....	.....	.....	.....	0.0	0.0	1½ + large stone.
11,650–11,680	30	10	1	.....	.....	.....	.....	.....	.....	(*)	(*)	Stone all gone.
11,680–11,770	90	9	2	.....	.....	.....	.....	.....	.....	(*)	(*)	Do.

* Top mattress destroyed by storm since July 24.

KIPP DAM.

This is the name given to the offset, nearly at right angles to the west jetty, connecting its upper end with the west shore.

No additions have been made here, and the only change is in the elevation of its upper surface.

Between July 17 and October 31 this has, in some way, become depressed about one foot. Ninety-five one-hundredths of a foot is the average depression obtained by comparison of measurements made at the two epochs named.

KIPP DAM.

A tabulated statement of its condition on November 10, and of the progress made in building it from July 24 to November 10, 1877.

Distances from pile No. 1, at the corner of west jetty and Kipp dam, in feet.	Length of division under consideration.	Number of tiers in place November 10, 1877.	Number of tiers built from July 24 to November 10.	Average width of tiers built since July 24.	Average thickness of tiers built since July 24.	Average elevation of upper surface of stone, excluding large ones, in feet.	Average thickness of stones on upper tiers, in feet.
200, shoreward	200	6	....	....	....	+1.6	2 deep and 18 wide.
200-300	100	6	....	....	....	1.6	Less than 2 deep and 18 wide.
300-420	120	5	....	....	....	1.5	Do.
420-580	160	*1	....	....	....	1.2	Do.
580-620	†40	1	....	....	....	....	....

* Constructed over loose willows.

† The last division, 40 feet, extends over the land, and is covered with a thin, narrow layer of stone.

THE WEST JETTY.

From 1,000 to 1,175 feet from pile 1 (upper corner of west jetty), and from 1,210 to 1,455 feet, also from 1,495 to 1,600 feet from the same point, a layer of willows 20 feet wide and two feet thick has been added to the west jetty, and on these a tier of stone 18 feet wide and 1 foot deep has been placed.

WEST JETTY.

A tabulated statement of its condition on November 10, and of the progress made in building it from July 24 to November 10, 1877.

Distances from pile 1, west jetty, in feet.	Length of section considered, in feet.	Number of tiers in place November 10, 1877.	Number of tiers built from July 24 to November 10, 1877.	Average width of tiers built from July 24 to November 10, in feet.	Average thickness of same, in feet.	Number of linear feet placed from July 24 to November 10.	Number of cords of willows used from July 24 to November 10.	Average elevation of upper surface of stone, excluding large ones, in feet.	Average thickness of stone on upper tier, excluding large ones, in feet.
10– 25 above	15	11	....	....	....	....	....	+1.5	1½
0– 10 above	10	8	....	....	....	....	....	+0.4	1½
0– 330 below	330	7	....	....	....	....	....	+0.3	1½
330– 430 below	100	5	....	....	....	....	....	+1.1	1½
430– 500 below	70	6	....	....	....	....	....	+2.0	1½
500– 800 below	300	5 + loose willows.	....	....	....	....	....	+0.7	1
800–1,000 below	200	5	....	....	....	....	....	+1.0	1½
1,000–1,140 below	140	5 + willows	*1	20	2	140	44	+1.2	1
1,140–1,210 below	70	7	....	....	....	....	....	0.0	1
1,210–1,455 below	245	5 + 1 of willows.	*1	20	2	245	76	+0.3	1
1,455–1,495 below	40	5	....	....	....	....	....	0.0	1
1,495–1,600 below	110	4 + 1 of willows.	*1	20	2	110	34	+0.3	1
1,600–1,850 below	250	4	....	....	....	....	....	+0.5	1
1,850–1,950 below	100	5	....	....	....	....	....	0.0	1
1,950–4,070 below	2,120	4 and 5	....	....	....	....	....	−0.2	¾ to 1½
4,070–4,200 below	130	5	....	....	....	....	....	+1.0	1½
4,200–6,825 below	2,625	5–6	....	....	....	....	....	+0.4	1½
6,825–7,200 below	375	6	....	....	....	....	....	−0.5	†2
7,200–7,380 below	180	7	....	....	....	....	....	−0.5	†2

* Tier of loose willows. † Some of this lately washed off the jetties.

THE WING-DAMS OR SPURS OF THE JETTIES.

Large letters indicate wing-dams starting from the east jetty and small letters those projecting from the west jetty.

There are now 33 spurs projecting from the jetties. At the date of my last report there were 29.

Four, then, are new structures. Five of the older ones have received additions or repairs, and 24 remain as last reported. Of the 5 that have been partially renewed or repaired, A and J spring from the east jetty and *a*, *g*, and *h*, from the west jetty.

The forty linear feet nearest the jetty of the top tier of spur A were destroyed by the storms of September 20 and October 1; and most of the stone on the spur was forced off into the water. This has not been replaced. A second or lower mattress-wall has been added to this spur since July 24. A cross-section through this spur, on sheet No. 4, together with data contained in the table relating to wing-dams, gives all necessary details concerning this important addition, and the table

gives also all needed information concerning other spurs not given in the body of this report.

Spur J has had 59 feet of its outer end renewed, and it has also been extended 81 feet farther into the river.

The top pier of the second wall of spur *a* was partially broken up by the two storms described and all its surface-stone was washed away. Stone has since been placed on the broken mattresses. Of wing-dam *g* 52 feet of the outer end were undermined, and 6 piles were carried away.

The inclined mattress has swung down-stream, and it is now attached to the spur at one end only.

Of wing-dam *h*, 40 feet of the outer end were undermined and 5 piles were carried away. The corresponding mattress was nearly lost. It is joined to the wing-dam, as described for wing-dam *g*.

WING DAMS OR SPURS

A tabulated statement of their condition November 10, *and of the*

Designation of spur.	Distance from East Point, or pile 1, of point on main jetty whence spur projects, in feet.	Order.*	Length from piles of main jetty to outer end of spur at bottom tier, in feet.	Number of piles in spur.	Number of tiers horizontal.	Tiers of — Length of tiers in order from below upwards, in feet.
A	11,770 East Point...	1	195 + 30 feet apron	Piles in 3 rows	5 and 7	160, 160, 78, 161, 150, 68, 150.
[1]A	11,770 East Point...	1	200		5......	160, 160, 160, 160, 146
[2]a	7,440 pile 1	1	199 + 30 feet apron	Piles in 2 rows.	7......	149, 165, 67, 116, 166, 168, 158.
[3]a	7,440 pile 1	1	199 + 30 feet apron		4......	170, 170, 160, 157.....
B	11,550 East Point...	3	About 150...........	(4)	......	....
b	7,220 pile 1	3	About 150...........	(4)	......	....
C	11,200 East Point...	1	203 + 53 feet apron..	23.............	3......	162, 171, 73..........
c	6,900 pile 1	1	205.................	26.............	2......	166, 166..........
D	10,600 East Point...	3	175.................	(6)	......	....
d	6,300 pile 1	3	140.................	(7)	......	....
E	10,000 East Point...	1	210 + 54 feet apron and piles.	28.............	3......	160, 160, 91..........
e	5,780 pile 1	3	197.................	20 (9).........		....
F	9,410 East Point...	3	185.................	20.............	......	....
f	5,400 pile 1	3	135.................	16.............	......	....
G	8,990 East Point...	3	244.................	25.............	......	....
g	4,770 pile 1	2	169.................	20.............	1......	30..................
H	8,000 East Point...	2	231.................	31.............	3......	234, 198, 100.........
h	4,065 pile 1	2	203.................	19.............	1......	193..................
I	7,110 East Point...	2	202.................	25 in 2 rows...	4......	177, 82, 164, 170......
i	3,105 pile 1	2	193.................	19.............	5......	160, 160, 160, 150, 160
65, 25 △ E. jetty	6,525 East Point...	2	210.................	27 in 3 rows...	1......	184..................
△ 65, 25 W. jetty	2,475 pile 1	2	240.................	38 in 3 rows...	1......	210..................
J	5,180 East Point ..	3	251.................	27.............	......	....
j	1,150 pile 1	2	180.................	15 in 3 rows...	1......	140..................
K	4,520 East Point...	3	185.................	16.............	......	....
k	433 pile 1	2	220.................	29 in 3 rows...	1......	170..................
L	3,800 East Point...	3	235.................	20.............	......	....
l	200 above pile 1..	3	790 from shore	30	......	....
M	3,500 East Point...	3	220.................	20.............	......	....
m	500 above pile 1..	3	710 from shore	....	......	....
N	3,000 East Point...	3	187.................	....	......	....
n	980 above pile 1..	3	500 from shore	....	......	....
O	2,600 East Point...	3	180.................	16.............	......	....
o	1,500 above pile 1..	3	440 from shore	40.............	......	....
p	2,160 above pile 1..	1	326 from shore	24.............	4......	326, 300, 256, 244....

[1] 2d wall.
[2] 1st wall.
[3] 2d wall.
[4] Destroyed previous to report of March 16, 1877, only piles remaining; no repairs.
[5] Excluding apron and projecting piles from consideration.
[6] Nothing done since March 16; 50 feet only of outer end effective.
[7] Nothing done since March 16; only piles remain.
[8] Minus 54 feet apron and piles, *i. e.*, they are not considered.
[9] The outer 56 feet has only piles.

OF THE JETTIES.

progress made in building them from July 24 to November 10, 1877.

horizontal mattresses.		Length of inclined mattresses, in feet.	Spur, new or old, *i. e.*, built since July 24 or not.	Number of linear feet horizontal mattresses built since July 24.	Number of linear feet inclined mattresses built since July 24.	Total number of linear feet of mattresses built since July 24.	Number of cords of willows used in mattresses built since July 24.	Clear space between two opposite spurs.		
Width in same order, in feet.	Thickness in same order, in feet.							At water-surface, in feet.	At middle depth, in feet.	At bottom between mattresses, in feet.
78, 63, 43, 23, 20, 20, 16.	2, 2, 2, 2½, 2, 3, 2.		Old						610	610
100, 75, 60, 40, 30	2, 2, 2, 2, 2		New	786		786	677			
80, 63, 43, 42, 23, 20, 20.	2, 2, 2½, 2, 2½, 2½, 2½.		Old						610	610
35, 30, 25, 25	2½, 2½, 2½, 3		Old							
			Old							
			Old							
25, 24, 22	2½, 2½, 2		Old						613	[*]613
22, 23	2½, 2½		Old						613	613
20, 20, 20	2½, 2½, 2½		Old							[8]634
		119	Old, good condition.							[10]634
		60 effective	Old							
		None	Old							About 730
		81 effective	Old					642	642	642
25	1½	132 effective, ([12]).	Old					642	642	642
20, 20, 20	2, 2, 2	135	Old					620	620	620
25	1½	83 ([13])	Old					620	620	620
20, 20, 20, 20	2½, 2½, 2½, 2½	142	Old					592	592	592
20, 20, 20, 20, 15	2½, 2½, 2½, 2½, 2½	160	Old					592	592	592
20, 30, and 60. ([14]).	2	146	New	184	146	330	106	606	606	[16]550
30 and 60 ([15]).	2	178	New	210	178	388	185	606	606	[16]550
		220	80 feet old. 140 feet new.		140	140	16	612	612	569
30	2	97	New	140	97	237	88	612	612	569
			Old					625	625	595
30 and 60 ([17])	2	160	New	170	160	330	112	625	625	[18]595
		About 40 effective.	Old					590	590	590
		None of much use.	Old					590	590	590
		100 outer end effective.	Old					570	570	570
		80 outer end effective.	Old					570	570	570
		150	Old					610	610	610
		500	Old					610	610	610
		60	Old					640	640	640
		None of use	Old					640	640	640
17, 12, 12, 12	2, 1, 1, 1		Old					800	800	800

[10] 56 feet of piles counted in.
[12] 52 feet of outer end has undermined and broken away since July 24.
[13] 40 feet of outer end has undermined and broken away since July 24.
[14] This tier varies in width; 74 feet is 20 feet wide, 80 feet is 30 feet wide, and 30 feet of outer end 60 feet wide.
[15] This tier varies in width; 180 feet is 30 feet wide, and 30 feet of outer end is 60 feet wide.
[16] Apron mattresses included.
[17] This tier varies in width; 140 feet is 30 feet wide, and 30 feet of outer end is 60 feet wide.
[18] 30 feet apron mattresses included.
* For explanation of classification see page 13, seventh Report.

Since July 24, about 1,800 cords of willows have been used at South Pass and about 3,000 cubic yards of stone.

A portion of this stone has been temporarily deposited on the upper 2,000 feet of the east jetty, to save leaking barges, and it may be removed elsewhere in the future.

DREDGING AT SOUTH PASS TO DECEMBER 15.

On the 24th of September a bucket-dredge, belonging to Kimball & Co., was moved down from the head of the pass, where it had lain idle for some time, and since that date it has been used to deepen the channel over the bar.

The weather at this season is exceedingly unpropitious for such work, with a dredging-machine, and in consequence, not very much had been gained, until lately. For a time the violent storms effected shoaling, where the dredge had been at work, and it is quite well demonstrated that an ordinary dredge can accomplish little on the bar itself, at this season of the year, at least.

But the dredging-machine has been quite useful *within* the pass of late. The dredge has worked about 40 days, and has removed about 12,000 cubic yards from the bottom. Some of this has been dumped close to the jetties, between the wing-dams, and some into the Gulf beyond the jetties, in deep water.

About the 10th of August the working force was greatly reduced, and since then the number of employés engaged in work at the jetties has been sixty or more, exclusive of about thirty employed on the new dredge-boat G. W. R. Bayley.

THE NEW DREDGE.

The new dredge-boat G. W. R. Bayley arrived at Port Eads November 15, before daylight. It was built not only to have a more powerful and effective dredge for the work in view than any of the more common kinds in use, but it is anticipated that it will be able to work on the bar, some of the time at least, when the ordinary dredging-machine would be forced to seek shelter; a very important consideration, when it is remembered that the water has been, at times, so rough that no hydrographic work could be done for a survey during periods of from two to three weeks. The following is a description of the boat and of the purposed modes of working it, gleaned from personal inspections and from information furnished by others:

This is an iron side-wheel steamboat, drawing about 5 feet with her coal on board, when unladen otherwise. Its length on deck is about 185 feet, with an after-deck frame, strongly supported, projecting 17 feet beyond a double stern, or a stern in two parts, each division being about 25 feet long, and having a rudder (while another rudder is at the bow). An interval or recess, 4 feet wide, between them, receives the suction-pipe and allows it free play vertically. Thus, from the stem to the after bulkhead of the main boat where the suction-pipe is attached, the length on deck is about 160 feet. The width amidships is 32 feet, and the depth of hold 10 feet. The entire boat is iron except the housing on the upper deck, the wheel-houses, and a few light details.

The plates of the hull are three-eighths of an inch thick. There are two fore-and-aft and six cross bulkheads, including tanks, all well braced with channel-iron webs. The deck is of iron plates, one-fourth inch thick, with lapped joints, held by flush rivets. A keelson, 3 feet

high, and double under the tanks, extends 125 feet from the stem and to the rear. Two cross and two longitudinal keelsons or girders support the pumps and pumping-engines.

To uphold the weight of the wheel-shafts and their accessories, two large iron gallows-frames are braced to the side of the hull. The wheel-houses are of wood, the wheels having a diameter of 28 feet. The boilers are four in number, of steel, forming two batteries, which are placed under the main deck. They rest on well-riveted girders. Each boiler is 26 feet long, with a diameter of 42 inches, and has four flues, two 9 and two 13 inches in diameter; allowable pressure, 159 pounds. Two high-pressure engines, having cylinders 21 inches in diameter, with a stroke of 7 feet, supply power for the side-wheels, and a doctor beneath the deck supplies the boilers with water. Besides these, there are seven engines for hoisting purposes, an hydraulic steam-ram, a Cameron pumping-engine, which supplies water for flushing the tanks, &c.; and, lastly, supported on iron frames well secured to the girders, are a pair of oscillating engines, the cylinders of each having a diameter of 20 inches, with a 20-inch stroke. The anticipated pressure on the piston-heads is 125 pounds per square inch.

Forward from the wheel-houses are four iron tanks, each 15 feet by 19 feet in plan, for 7 feet below their separating walls, having hoppers of an inverted pyramidal shape, thence to their bottoms, 7½ feet lower. These have each a valve-door, 4 feet in diameter, opening outward or downward, and upheld by an hydraulic jack supported by timbers on a level with the upper edges of the tanks about 5 feet above the tops of the division partitions. Power is supplied to these jacks, through pipes, by the steam-ram before mentioned, by merely opening the proper valve, the steam-power being constantly on duty at the piston-head of the ram, far astern.

These four tanks, laden to their party-walls, contain about 433 cubic yards. If filled two feet higher, until the overflow on each side is reached, they hold 512 cubic yards. This latter lading would cause the boat to draw about 9½ feet, and settle her nearly to her guards, so that calm water will be needed for this practice.

A wooden horizontal waterway, with trap-doors for each tank, leads over the tanks and connects at its rear end with an inclined waterway, which in turn is joined by a cylindrical pipe 24 inches in diameter about 20 feet forward of the pump. This is connected, in actual operation, with a 24-inch pipe which flares out to 30 inches in diameter where it joins the pump, 9 feet below the horizontal wooden trough.

This description applies when the pump is filling the tanks. But the discharge may be made overboard on either side of the boat. And in this case a pipe 75 feet long or less, as is needed, is carried out directly at right angles from the boat, amidships nearly, and is supported by a derrick. Then the vertical height of the discharge, above the exit from the pump, is about 4 feet less, or 5 feet. The pipe leading from the pump is, in these cases, turned to the port or starboard at its outer end, and its length is so adjusted that its 24-inches extremity joins either the upper and middle discharge-pipe leading to the tanks, or either of the lower two leading outside.

The pump is centrifugal in action, of the Andrews patent. The diameter of the fan-wheel is 6 feet, and its depth in the direction of its axis is 2 feet 3 inches, and about one hundred revolutions per minute have been attained, while the machinery is new. Leading astern from the entrance to the cylinder of the pump, the suction-pipe connects with a large iron casting firmly attached to the stern, between the two wings

of the boat, before described. On this casting is the curved surface which forms one-half the joint which allows vertical motion to the discharge-pipe. A second casting having at its forward end a *female* curve corresponding to that on the fixed casting, and on its after end the *male* curve forming half of the joint which gives horizontal motion, is firmly connected to trunnions on the vertical sides of the fixed castings by stirrup-straps. At the after end of the second casting the joint giving horizontal motion is completed, and the suction-pipe is then attached so that a horizontal motion of about 30 degrees on each side of the axial position is attainable, when the suction-pipe is depressed at work. A vertical section parallel to the axis of the first joint, and a horizontal section parallel to the axis of the second is nearly semicircular, while sections at right angles would be rectangular. The suction-pipe is 27 inches in diameter. Its length is calculated so that it shall make an angle of about 35 degrees with a horizontal bottom, when working in 28 feet of water. The end of the suction-pipe terminates in and forms the upper half of the drag, which is composed of two main parts, hinged together, so that the upper or outer part, when dredging, shuts over the other, moving vertically with the end of the suction-pipe, increasing the width of the aperture through which the sand passes, as the steel scraper, which is on the movable part, moves downward. The drag flares out horizontally, so that the scraping-edge is 4 feet long, while the square box adjoining the inner or circular end is 27 inches on a side. In passing up from the cutting-edge to the pump the dredged material goes through a curved chamber, which is a prolongation of the suction-pipe, but having a very different shape, with the same area of cross-section. This chamber turns through about one-half of a circumference. Five ribs on the under joint or half of the drag, are partly buried in the bottom as the drag is moved along, and small plows may be used on them, and water forced by the Cameron pump through a pipe leading over the suction-pipe and down through a six-inch hole on each of the vertical sides of the drag, may be led thence, through pipes, between these ribs, so as to form jets, which may assist the action of the scraper by loosening the material of the bottom. The aperture before the cutting-edge may be closed or opened by an hydraulic jack placed on the suction-pipe, and operated by the steam-ram. As the plunger of the jack moves to do this work a smaller mate connected with it moves a liquid in a gauge on deck by means of an intervening small pipe, so that an observer may know how large the aperture is.

The drag terminates at either flank on its upper side in two ears, which are open above so that water may pass freely into a nearly cylindrical space which would otherwise be an air-chamber. Once here it is drawn beneath an iron plate, above the sand-scraper, so as to mix with the sand and aid in giving it free passage up the suction-pipe to the pump.

This plate is adjustable by two set-screws, and it is placed so that the water-aperture increases as the sand-entrance contracts, and *vice versa*. The minimum limit to the width of the aperture is 1 inch, and the maximum limit 12 inches, and the length (across) is 4 feet for each. When the sand-aperture is 4 inches wide the water-entrance is 12 inches, and the reverse holds true. The suction-pipe is attached by chains to a gin, and it is raised or lowered by the power of an engine placed on deck, abaft the after bulkhead, for the purpose. A machine, so carefully and elaborately conceived and so thoroughly constructed, must needs insure at least some fair measure of success, provided the scraper can be made to perform the part assigned to it. The attainment of this end neces-

sarily involves repeated trials and changes of detail, and unless a happy expedient giving the desired economy is accidentally obtained at first considerable time may be required for experimenting. To be prepared for such a contingency, a second end to the suction-pipe was brought from Pittsburgh, where the boat was made. This is intended to be pushed instead of being dragged.

An iron cylindrical roller some 7 feet in diameter, mostly open at the sides, will rotate about its axis, around which is built, inside, a small air-tight drum, serving to diminish the specific gravity of the whole device.

The frame which carries the cutting-edge partly closes the sides of the cylinder, and this does not rotate.

A second part joins the first part, behind the cutting-edge, by one bolt on each side, so that a motion on these bolts as an axis is easy. Where the junction is made, the chamber up which the sediment is to be drawn is flat and wide. But at the other extremity the second part becomes cylindrical.

Here junction is made with a third part by a sliding cylinder, one joint telescoping on the other.

A chamber in the third part is surmounted by four iron pulleys, so arranged that timbers on each side passing under one pulley and over another shall serve to transmit the power of an hydraulic jack, in order to give the telescoping-motion which will lengthen or shorten the whole apparatus. It should be mentioned that inside the guards is an iron bulwark, everywhere 5 feet high at least, surrounding the main part of the boat. The doors in this wall are made to close water-tight, and thus the boat is quite well guarded from danger arising from shipping seas while at work.

As the boat has two rudders at one end, and one at the bow, it is intended that it shall not be turned about while at work, but, after emptying her tanks in deep water, that she will back up to a new position and commence dredging anew. The tanks have been filled with water in six minutes.

If 20 per cent. of sediment can be pumped up and fifteen trips per day accomplished, 1,300 cubic yards of the bottom may be removed in ten hours.

With 12½ per cent. of sediment and thirty trips each day, about 1,600 cubic yards may be removed from the channel. This percentage and a greater number of trips have been attained in working on the crest of the bar, making short trips; but, as the tanks were not all filled, often the aggregate gain was considerably less than this for ten hours.

Since the above description was written some changes of detail have been made in the scraper. The motion of the two parts about a common hinge has been temporarily discarded, and other slight changes have been made. But as the boat will probably undergo still other alterations in detail, it is unnecessary for the present to enlarge its description.

The 30th of November, I took seven samples of the water, charged with sediment, from the mouth of the discharge conduit of the boat, where the water is always agitated very violently. The samples were taken in this case at the stages of seven successive trips when an average turbidity was apparent, as well as could be judged; 935 grammes of water and sediment contained 86.222 grammes of dried sediment, about nine-tenths being sand and the rest of a clayey nature. This test shows a percentage of sediment to water charged with sediment of 9.3.

When this water was first taken up it seemed to contain a large amount

of mud. The fluid mass was of a chocolate color, but after the water had been filtered and the sediment dried, it became apparent that about nine-tenths of the solid matter was fine sand, somewhat dark in color in the mass. This kind of sand, having dark-colored clay mixed with it in proportions varying from 5 to 20 per cent., has been mistaken for mud, as it is taken from the river in suspension in the water. It settles much more slowly than sand is usually precipitated.

Water in suspension in the sample jars of the later part of July, 1877, seemed, in this manner, to be mud nearly free from sand, and it was so reported by me. But a careful microscopic examination of the dried residuum, left after filtering, showed that finely comminuted sand constituted by far the larger proportion in many samples.

It is difficult to judge accurately of the proper specific gravity of this matter as it lies on the bottom.

If it is assumed to have the average specific gravity of the river sediment 1.89, the volume of the bottom removed is 4.97 cubic yards for each 100 cubic yards of sediment-charged water in the tanks. Allowing 45 trips in this day's work, with an average of 3 tanks per trip, the same proportion throughout 10 hours' work would result in removing about 720 cubic yards from the bottom.

December 7, 1877, 8 samples from 4 trips gave 12 per cent. of sand by weight. Assuming the specific gravity of the sand in the bottom to be 1.8, the volume removed in 10 hours' work on the basis above given, would be 974 cubic yards.

The same day 24 samples from 10 trips yielded 12.3 per cent. of sand by weight. A day's work with this percentage would aggregate about 1,000 cubic yards. December 9, about 20 samples were taken during 8 trips, at regular intervals. 9.87 per cent. by weight of sand resulted. A day's work corresponding to this would be 801 cubic yards. December 12, about 15 samples taken from 3 trips were preserved. Mud was thrown into the tanks, a part of the time, so thick that it tasked to the utmost the power of the pump to keep the mass in motion. At these times the mud was of about the consistency of thin mortar, but, after drying, this proved to be almost entirely a very fine sand, the grains showing rounded corners and edges under the microscope. Four samples were taken of this sort, and 11 at other stages of the trip. The percentage of dried sediment to the whole mass, by weight, was 39.02. Assuming this material to have a specific gravity of 1.89 when compact on the bottom, a day's work at the same rate would accomplish the removal of about 3,000 cubic yards. The average removal from the bottom of 1,200 cubic yards per day is not too much to anticipate as a full day's work, when experience has demonstrated the best manner of working the dredge.

When the new dredge began its experimental work the interruption to the 22 feet channel, *i. e.*, from 22 feet inside on the bar to 22 feet outside, was 50 feet only. At that time and since the old dredging-machine could have worked very little on the bar. Some of the effects of the work of the Bayley are shown by reference to the report of the monthly bar survey, dated December 1, 1877. A 22 feet trench extended through to deep water. This was twenty-one days after the arrival of the Bayley; but it had then worked only five days, under the disadvantages of new and nearly untried machinery and devices.

THE PRESENT SURVEY.

The field-work of the present survey, at the lower end of the jetties and beyond, has been delayed by various causes. The channel showed

sufficient progressive improvement while the river was quite low, to warrant the belief that the new dredge, Bayley, would be able to deepen and widen it shortly after beginning work, assuming that experimental tests had resulted in the ascertainment of permanent methods of adjustment and use of various details, especially of the scraping-device.

But low water in the Ohio River not only detained the boat at Pittsburgh long after it was desired to move it to Port Eads, but the grounding of the boat prevented the needed trials and tests from being made before it reached Port Eads. Consequently, the earlier dredging-work here was done under circumstances quite unfavorable to rapid progress. A considerable part of the Bayley's machinery was brought to Port Eads on barges, and the proper placing of this, together with certain finishing work, consumed considerable time. A rise in the river also acted unfavorably.

Nevertheless, it was thought best to occupy the time with office-work connected with the survey, meanwhile awaiting the action of the dredge and of the river a reasonable period, before proceeding to finish the field-work, in order to avoid an unnecessary intermediate survey, which would necessarily be brief and unsatisfactory in connection with an event so important as the attainment of a channel 22 feet deep and 200 feet wide, and the payment of the second installment of half a million of dollars due from the United States on the procurement of that channel.

Elsewhere I have given an approximate account of the work accomplished on certain days by the dredge, in terms of cubic yards removed from the bottom.

When the channel had become so nearly of the depth and width required for the second payment that only about 300 feet in length needed widening by a mean amount of less than 30 feet, I made nearly daily reconnaissances of the critical portion of the channel.

On the 14th of December I sounded finally the lower 1,270 feet of the channel, and a portion of the area beyond the ends of the jetties, and, on the 15th of December, I completed the survey of the channel by sounding 1,200 feet in length, overlapping by that length work done on December 7; and I also sounded again over the narrowest cross-section at the ends of the jetties.

A careful watch has been kept throughout, over all localities where a narrowing of width could affect the question of attainment of a 22-feet channel 200 feet wide.

The soundings of the 14th and 15th of December, when plotted, showed that the required channel had been obtained, and accordingly I addressed a letter to the honorable the Secretary of War and to Mr. Eads, the latter including a duplicate of the former.

A copy of the former is given below:

UNITED STATES ENGINEER OFFICE,
Port Eads, South Pass, La., December 17, 1877.

SIR: I have the honor, in compliance with the act of Congress approved March 3, 1875, entitled "An act making appropriations for the repair, preservation, and completion of certain public works on rivers and harbors, and for other purposes," to report, in confirmation of my telegram of yesterday, that "yesterday, December 15, a channel 22 feet deep throughout a width of more than 200 feet, at its narrowest point, was obtained from deeper water in South Pass, near the head of the passes, through the jettied prolongation of South Pass, to deeper water in the Gulf of Mexico."

I have also furnished Mr. Eads, with a duplicate of this letter.

Not over one day's field-work will be required to complete the pending survey, and after a few days' office-work following the taking of soundings in the Gulf, near the

ends of the jetties, certified charts with others will be forwarded to the honorable Secretary of War and to Mr. Eads, and at that time, or soon after, a report to accompany the charts will be mailed to both addresses.

I certify that the facts above stated as to widths and depths of channel are correct and in conformity with the results of my latest surveys.

Very respectfully, your obedient servant,

M. R. BROWN,
Captain of Engineers, U. S. A.

Hon. GEO. W. McCRARY,
Secretary of War, Washington, D. C.

In obtaining the channel 22 feet deep for a width of 200 feet, the dredge Bayley has worked about 20 days of 10 hours each and the dredging-machine about twice that number.

At 800 hundred cubic yards per day the Bayley has removed about 16,000 cubic yards from the bottom. Allowing 300 yards per day's work of the dredging-machine, the 40 days' work result in the removal of 12,000 cubic yards. In all, about 28,000 cubic yards of the bottom have been removed since late in October.

Inasmuch as this amount is greatly in excess of that required to obtain a channel 22 feet deep and 200 feet wide in the early days of November, it is plain that the river has been working against the dredges, although some of the dredged material has come from the jetty sides of the 22 feet contour.

In the following table, the depth of water available for navigation through each section of 2,000 feet of the channel below East Point is given for various dates, including those of the latest surveys:

Table of available depths.

Date.	Distances, in feet, from East Point.					
	0–2,000	2,000–4,000.	4,000–6,000.	6,000–8,000.	8,000–10,000.	10,000–12,000.
June, 1875	22.5	18.7	16.7	10.2	9.7	9.2
May, 1876	23.3	20.3	22.0	21.0	17.1	15.0
August, 1876	23.5	19.6	21.0	23.5	23.0	19.8
November, 1876	22.0	20.3	21.1	21.2	21.1	20.3
March 16, 1877	24.1	21.1	23.2	22.0	21.2	20.5
April 2, 1877	......	......	......	......	......	21.3
April 22, 1877	......	......	......	......	......	20.5
May 10, 1877	......	......	......	22.1	21.4	19.5
May 24, 1877	......	......	......	......	......	17.8
June 28, 1877	......	......	......	......	......	18.0
July 3, 1877	24.9	24.0	......	......	23.5	......
July 7, 1877	......	......	......	23.8	......	......
July 8, 1877	......	......	26.0	......	......	......
July 28, 1877	......	......	......	......	......	20.3
August 30, 1877	......	......	......	......	......	20.6
September 28, 1877	......	......	......	......	......	20.7
October 25, 1877	......	24.4	......	......	......	......
October 31, 1877	......	......	......	......	......	21.0
November 3, 1877	26.3	......	28.5	......	......	......
November 13, 1877	......	......	......	24.2	......	......
December 1, 1877	......	......	......	......	......	21.3
December 7, 1877	......	......	......	......	23.0	......
December 14, 1877	......	......	......	......	......	23.7

On sheets Nos. 1 and 2, in addition to the hydrography of South Pass, near to and between the jetties and beyond them, the references of the mean upper surface of the jetties, including the stone superposed on them are given, the standard plane being the accepted "average flood-tide."

In the present survey especial care has been taken to extend the investigation to some distance on either side of the jetties' ends and to the shoal areas behind the jetties as far up as a boat can be floated.

No survey since that of August, 1876, is sufficiently detailed as to depths near to and behind the jetties to serve as a standard with which to compare the present chart; and no survey gives many details as to depths behind the east jetty and considerably distant from it. By combining a comparison of the present survey and that of August, 1876, with knowledge as to changes patent to all who have been constantly or often at Port Eads since the works were first sufficiently far advanced to train and concentrate the flow of water in the pass, the following appears:

At the first, the water behind the east jetty, extending about a quarter of a mile from it at least, showed a tendency to become slowly shoaler.

But comparing the present survey with that of August, 1876, it appears that the water *near* to the lower 7,770 feet of the end of the east jetty has deepened somewhat, as follows: For a width of 600 feet to the eastward of the east jetty several consecutive sections, beginning at 11,770 feet from East Point, have deepened an average amount indicated by the following numbers: from 11,000 to 11,770 feet from East Point, 4.01 feet; from 10,000 to 11,000 feet, 1.45 feet; from 9,000 to 10,000 feet, 0.59 foot.

For a width of 300 feet from the east jetty, several consecutive sections have deepened, as follows:

	Feet.
From 8,000 to 9,000 feet from East Point	0.47
From 7,000 to 8,000 feet from East Point	1.15
From 6,000 to 7,000 feet from East Point	1.49
From 5,000 to 6,000 feet from East Point	1.16
From 4,000 to 5,000 feet from East Point	0.95

Above a point 4,000 feet from East Point shoaling has apparently been uninterrupted, and where formerly water flowed freely at low tide, a rank growth of cane and grass is now found on land as high, in some cases, probably, as most of it bordering the pass near Port Eads.

It is the general judgment, also, that for the greater part of the length of the east jetty the water at a distance of 1,000 or 2,000 feet from the mattress-wall has been getting shoaler with the lapse of time, as is evidenced by the increasing amount of land, and even of grass, thought to be visible at low stages of the tide and river. But no surveys are sufficiently detailed to show this, and the labor involved in making the necessary soundings and leveling is too great to warrant the work.

Since the jetties have been raised above average flood-tide, the slope of the pass, at low tide of a high stage of the river, has been known to involve a fall of 1.1 feet in about 3 miles.

At high tide of high river a fall of .40 foot has existed.

The water rushing over and through the east jetty seems to have carried away the mud near the jetty, formerly overlying the sand here.

But behind the west jetty shoaling has been progressive and constant. Since May, 1875, the greatest average fill, 12.3 feet, has occurred at the upper end of the jetty, over an area of 800 feet lengthwise of the jetty and 500 feet transversely.

Thence to the lower end of the jetties the shoaling gradually diminishes, until over an area parallel lengthwise of the last 1,000 feet of the west jetty and 500 feet wide the fill averages 1 foot.

This shoaling is due to deposits of fine sand mostly; clay is intermixed with it in sufficient proportion to give water overcharged with it a muddy appearance.

A comparison of the positions of the middle portion, 1,050 feet, of the 20, 30, and 40 feet curves, December 15 and June 22, 1877, respectively,

by measuring ordinates 50 feet apart, as described in another page of this report, shows that between these two dates this portion of the 20 feet curve receded 231 feet, the corresponding part of the 30 feet curve receded 76 feet, and the same portion of the 40 feet curve receded 343 feet.

If 3,350 feet of these curves, symmetrically disposed with reference to the middle 1,050 feet, and including these middle portions, are considered, we find that the 20 feet curve has receded 75 feet, the 30 feet curve 136 feet, and the 40 feet curve 315 feet.

If a comparison of the present chart with the chart of the survey of July 28, 1877, is made by the same method, there results a recession of 518 feet for the middle 1,050 feet of the 20 feet curve and a recession of 134 feet for the middle 1,050 feet of the 30 feet curve.

These numbers indicate a general recession of the three curves so great in amount, that the measurements and computations have been repeated several times in order to detect possible errors, but a constant agreement of results within a very few feet is an assurance of their accuracy.

In measuring ordinates of the 30 feet curve of December, two isolated closed curves to the east of the prolongations of the jetties were considered as parts of the main curve, as they formed parts of the main curve on the June chart.

On the December chart the large area nearly inclosed by a portion of the 40 feet curve, partly included between the prolongations of the jetties and partly to the west of these prolongations, is considered in measuring ordinates. For this 40 feet line is probably connected with the main curve far to the westward, and a fair comparison requires its inclusion in any case.

As stated elsewhere, each elementary ordinate accepted is the sum of those portions of the ordinate in question which traverse depths less than that which designates the curve. So that all shoaling and all scour which affect either of the main curves involved in the comparison is considered in the result. But inclosed curves, which have not formed parts of the main curves within the period covered by the comparison, are neglected.

The cases where inclosed curves are considered are specially noted in each instance.

BAYOU GRANDE.

The best attainable data with reference to the proportionate amounts of water discharged by Lower South Pass and Grand Bayou in 1875 is to be gathered from the results of the official survey of each by a Coast Survey party, working under orders to execute a section of the act of March 3, 1875, granting the concession to Mr. Eads and associates.

The bayou was said to discharge then about 27 per cent. of the whole volume of South Pass above it.

The dam built in Grand Bayou by the jetty company in 1876 is located about 4,200 feet below the junction of the pass and the bayou. In 1876 a dam at the junction of the two streams was commenced, but difficulties, caused by eddies and the swift current and by drift-wood, caused the upper location to be discarded, except that a slight wing was built from the west shore of South Pass, at the head of the bayou, to catch drift.

It is understood that the intention to build a dam at the upper location was not permanently and definitely abandoned, but in any case a lower dam would be almost necessary to check the current and modify the eddies before building the upper dam.

After the lower dam had been made quite efficient, for the time, by a strong system of horizontal mattresses superposed each on the lower, for the greater portion of the water's depth, and a strong system of piles, in support and inclined mattresses, as a finish for the upper portion, so little water was wasted that the current above the dam nearly ceased, and the leakage was insignificant.

But gradually the dam has deteriorated, principally by the fall of the inclined mattresses to a horizontal position.

But compression, and, perhaps, some sinking, has contributed to the deterioration.

On the 1st of August, I found 7 per cent. of the whole volume of South Pass escaping over and through the dam. But soon after a much greater current was discovered in the bayou, and on the 6th of October, by a gauging of both streams when the moon was on or near the celestial equator, and the rise and fall of the tide nothing or nearly that, it was found that the bayou wasted about 15 per cent. of the whole volume of South Pass.

November 30 I gauged South Pass at Falconer's, above, and also at Cory's base, below, Grand Bayou, the moon having its zero declination nearly, and the tide absent. It was found that 21 per cent. of the volume of South Pass was then escaping by way of Grand Bayou and through a small canal for skiffs, called "Picayune Bayou," itself dammed by mattresses

The tests of the jetty engineers at different dates agree well with these ratios, and they are not very far from correct, and 15 per cent. may be accepted as the approximate mean loss of South Pass by way of Grand Bayou for the last four months or more.

From the fourth report on the South Pass improvement the condition of the dam on August 2, 1876, may be understood. A cross-section is shown on sheet No. 1.

On sheet No. 3 of the present survey a longitudinal section through the dam, which is a cross-section of the bayou at the dam, is shown.

A comparison of these sections gives an idea of the decadence of the dam. Apparently, the mattresses have become compressed or have sunken or are lost, so that the water is, averaging, at least 9 feet deeper than in August, 1876.

It is understood that an effort will be made to recapture securely the diverted volume by the establishment of a dam at the location earliest contemplated for its site, so as to nearly continue the western bank of the pass across the gap.

December 18. Work is now being prosecuted to rebuild the old dam.

DISCHARGE THROUGH SOUTH PASS OF WATER AND SEDIMENT FROM JULY 10 TO DECEMBER 1, 1877.

Whenever the moon is at its zero declination, and hence, when the rise and fall of the tide is slight, the weather and the absence of more pressing duties allowing, South Pass is gauged, and occasionally the three passes nearly simultaneously.

The following are recent results:

Table giving results of gauging in the three passes and Grand Bayou since August 14, 1877

Date.	Discharge of Northeast Pass, in cubic feet per second, near its head.	Discharge of Southwest Pass, in cubic feet per second, near its head.	Discharge of Grand Bayou in cubic feet per second.	Discharge of South Pass in cubic feet per second.	Location of velocity-base in South Pass.	Reading of Carrollton gauge.
August 14	....	....	....	37, 915	Coal-yard opposite South Pass light-house.	2. 90
September 8	103, 086	125, 256	....	....	....	0. 30
September 9	105, 220	117, 204	....	19, 068	Falconer's base	0. 40
September 10	119, 609	125, 898	....	29, 778	Falconer's base	0. 40
September 10	....	....	....	23, 599	Falconer's base	0. 40
October 6	....	....	3, 324	17, 674	Coal-yard	0. 30
November 30	....	....	....	41, 286	Falconer's base	3. 10
November 30	....	....	....	32, 478	Cory's base	3. 10

The average reading of the water-level gauge at Carrollton from July 10 to December 1, 1877, was 3.12 feet.

November 30, the discharge of South Pass being 41,280 cubic feet per second, the Carrollton gauge indicated 3.10 feet.

From September 9 and 10 to November 24 the river rose 2.5 feet at Carrollton. Hence, a rise of $\frac{1}{10}$ of a foot corresponded to an increase of discharge per second of 635 feet.

Applying this rate for $\frac{1}{5}$ tenth of a foot, the difference between the mean reading of the Carrollton gauge and that on November 30, to the discharge ascertained for November 30, and there results 41,407 cubic feet per second as the approximate mean discharge of South Pass from July 10 to December 1, 1877.

Using the results obtained September 9 and 10 from velocity observations taken in Southwest and Northeast Passes, by Mr. H. C. Collins, Captain Howell's assistant, and in South Pass by myself, it is seen that South Pass discharged 19.86 per cent. of the water flowing in Southwest Pass, and 21.47 per cent. of that in Northeast Pass, at 9.35 per cent. of the flow of the Mississippi River above the head of the passes.

At the date of the previous test the discharge of South Pass was a percentage of that of Southwest Pass, Northeast Pass, and of the whole river, respectively, indicated by the following numbers: 25.06, 23.67, and 10.85.

The sediment-table which follows is used to form the sediment-curve on sheet No. 4, by employing all observations in each set of five consecutive days to ascertain a single ordinate of the curve.

The sediment at middepth seems, at moderately low stages of the river, to vary indifferently on either side from the mean amount of sediment in the river.

When five days are combined, the five results, at 15 feet depth, give a mean result, which may, without great error, be taken as the mean ratio of sediment to water on the pass in the five days.

When samples are taken at various equal intervals, vertically, the mean of all is accepted as the mean result for the day.

The mean of all the ordinates from July 10 to December 1 indicates a mean ratio of sediment to water during the period of about .0005.

The mean specific gravity of the sediment being accepted at 1.89, from the data above given, there results an approximate discharge of

sediment through South Pass, during the 143 days from July 10 to December 1, of 5,012,642 cubic yards.

The approximate corresponding normal discharge from March 26 to July 10 was 13,647,532 cubic yards.

In 250 days, from March 26 to December 1, the approximate amount of sediment discharged from the pass above Grand Bayou was then 18,660,174 cubic yards. Of this amount, Grand Bayou discharged about 1,707,223 cubic yards, and the remainder, 16,952,951, is the discharge of Lower South Pass between, and over, and through the jetties, exclusive of sediment scoured from the bottom below South Pass lighthouse.

These estimates include the sediment carried along the bottom, as well as the quantity more strictly in suspension.

During rapid fluctuations in the level of the river at New Orleans an effort will be made to collect samples here twice each week, at three points in a cross-section, which is chosen at the velocity-base, at the surface, and a depth of 8, 16, 24, and 32 feet in the thread of the current, and at surface, middepth, and near the bottom at two points, each of which is midway between a bank of the pass and its deepest channel.

The effects of the tide on the amount of suspended sediment cannot be accurately eliminated. But as a long series of observations will include many stages of the tide, the effect in modifying the ratio of sediment to water will be so nearly annihilated that the results may be accepted with considerable confidence, always remembering that they profess to be only approximations, although sufficiently exact, probably, for most purposes for which they may be needed.

Table exhibiting the results of analysis for sediment of samples of water taken from South Pass of the Mississippi River, 2,000 feet above East Point (opposite South Pass light-house), and 250 feet from the west shore, from July 26 to November 27, both dates inclusive.

Date.	Time.	Depth at which specimen was taken, in feet.	Ratio of sediment to water, by weight.	Tide.		Carrollton gauge.	Maximum and minimum reading of gauge; time and difference of same, 2.76 feet being the reading for average flood-tide.					Remarks.
							High water.	Low water.	Difference.	Time.		
										High water.	Low water.	
1877. July 26	5.15 p.m.	Surface	.0009474	2.20	Falling....	8.80	3.35	2.11	1.24	9.05 a.m.	9.10 p.m.	Mostly very fine white sand, with a few larger maximum diameter 0.002 inch.
	5.15 p.m.	15	.0011409	2.20	....do	8.80	3.35	2.11	1.24	9.05 a.m.	9.10 p.m.	Nearly all sand from 0.003 to 0.01 inch in diameter.
	5.15 p.m.	30	.0013921	2.20	....do	8.80	3.35	2.11	1.24	9.05 a.m.	9.10 p.m.	Nearly all sand from 0.002 to 0.02 inch in diameter.
27	1.10 p.m.	15	.0010507	2.78	....do	8.50	3.03	2.25	0.78	10.15 a.m.	9.45 p.m.	Mostly sand.
30	1.15 p.m.	15	.0010044	2.36	....do	7.50	2.57	2.36	0.21	12.00 p.m.	0.00 a.m.	About three-fourths sand, fine and coarser.
Aug. 2	1.30 p.m.	15	.0012311	2.00	....do	6.95	2.89	1.94	0.95	1.25 a.m.	2.30 p.m.	Nearly all sand from 0.003 to 0.01 inch in diameter.
3	1.15 p.m.	15	.0011940	1.87	....do	6.80	3.06	1.84	1.22	2.55 a.m.	3.50 p.m.	Nearly one-half fine white sand; maximum diameter 0.0005 inch, averaging, perhaps, 0.002½; the rest clay.
4	1.30 p.m.	15	.0010032	1.68	....do	6.60	3.13	1.64	1.49	3.20 a.m.	3.40 p.m.	Nearly all sand from 0.003 to 0.01 inch in diameter.
6	1.30 p.m.	15	.0010613	1.70	....do	6.15	3.18	1.27	1.91	5.40 a.m.	4.35 p.m.	Over one-half sharp white sand, mostly fine, much less than 0.001 inch in diameter; a few grains 0.003 to 0.005; the rest clay.
7	10.15 a.m.	Surface	.0004989	2.75	....do	6.00	3.25	1.23	2.02	6.40 a.m.	7.45 p.m.	About one-half sand, fine.
	10.15 a.m.	15	.0008099	2.75	....do	6.00	3.25	1.23	2.02	6.40 a.m.	7.45 p.m.	About one-half sand, fine and coarser.
	10.15 a.m.	30	.0013673	2.75	....do	6.00	3.25	1.23	2.02	6.40 a.m.	7.45 p.m.	Nearly all sand from 0.003 to 0.01 inch in diameter.
8	1.30 p.m.	15	.0009325	2.00	....do	5.60	3.07	1.19	1.88	7.35 a.m.	....	Less than half sand, fine and coarser.
9	1.15 p.m.	15	.0007559	2.30	....do	5.20	2.95	1.54	1.41	10.30 a.m.	8.30 p.m.	More than half sand, fine and coarser.
10	1.40 p.m.	15	.0008328	2.45	....do	4.80	2.79	1.85	0.94	10.40 a.m.	9.45 p.m.	About one-third fine sand; the rest clay.
11	1.35 p.m.	15	.0007074	2.43	....do	4.40	2.57	2.12	0.45	11.55 a.m.	6.40 p.m.	Nearly half sand.
13	1.00 p.m.	15	.0011291	2.00	Stationary	3.40	2.80	2.00	0.80	11.05 p.m.	0.50 p.m.	About one-third sand from 0.003 to 0.01 inch in diameter.
14	1.00 p.m.	15	.0008316	1.82	Rising	2.90	2.77	1.77	1.00	0.30 a.m.	0.35 p.m.	About one-third sand.
15	1.10 p.m.	Surface	.0003651	1.70	Falling ...	2.70	2.90	1.54	1.36	0.40 a.m.	....	Very little sand.
	1.10 p.m.	15	.0009016	1.70	....do	2.70	2.90	1.54	1.36	0.40 a.m.	....	About one-third fine sand; the rest clay.
	1.10 p.m.	30	.0012641	1.70	....do	2.70	2.90	1.54	1.36	0.40 a.m.	....	About one-half sand, fine.
17	0.50 p.m.	15	.0008851	1.55	....do	2.50	3.00	1.50	1.50	2.10 a.m.	3.10 p.m.	About one-half sand, fine and coarser.
20	0.50 p.m.	15	.0002106	2.22	....do	2.00	3.22	1.66	1.56	5.45 a.m.	5.30 p.m.	A small proportion of very fine sand.
21	0.50 p.m.	15	.0002320	2.17	....do	1.80	3.10	1.62	1.48	7.10 a.m.	5.30 p.m.	A trace of very fine sand; clay probably.
22	1.00 p.m.	Surface	.0002148	2.20	....do	1.70	2.90	1.57	1.33	8.00 a.m.	....	Do.
	1.00 p.m.	15	.0002294	2.20	....do	1.70	2.90	1.57	1.33	8.00 a.m.	....	A little sand; mostly clay probably.
	1.00 p.m.	30	.0006305	2.20	....do	1.70	2.90	1.57	1.33	8.00 a.m.	....	A trace of fine sand.
24	4.00 p.m.	15	.0001750	1.80	....do	1.10	2.58	1.14	1.44	8.35 a.m.	....	About one-fourth very fine sand.
26	0.50 p.m.	15	.0001431	2.19	Stationary	0.90	2.28	1.76	0.52	....	....	A trace of very fine sand.
27	2.00 p.m.	15	.0001670	2.49	Rising	1.10	2.77	1.86	0.91	....	....	A trace of fine sand.
31	2.05 p.m.	Surface	.0000942	1.40	....	1.30	2.91	....	....	0.00 a.m.	....	No sand; some vegetable colors; rest probably clay.
	2.05 p.m.	6	.0002198	1.40	....	1.30	2.91	....	....	0.00 a.m.	....	About one-fourth sharp sand; diameter 0.001 to 0.008 inch.
	2.05 p.m.	12	.0001404	1.40	....	1.30	2.91	....	....	0.00 a.m.	....	No sand; some vegetable colors; rest probably clay.

	2.05 p. m	18	.0002497	1.40	....	1.30	2.91	....	.....	0.00 a. m	....	Do.
	2.05 p. m	24	.0003603	1.40	....	1.30	2.91	....	....	0.00 a. m	....	Do.
	2.05 p. m	29	.0004908	1.40	....	1.30	2.91	....	....	0.00 a. m	....	Do.
Sept. 6	4.30 p. m	Surface	.0000988	1.26	....	0.80	3.16	0.96	2.20	....	....	No sand.
	4.30 p. m	6	.0001492	1.26	....	0.80	3.16	0.96	2.20	....	....	No sand; some vegetable colors; rest clay probably.
	4.30 p. m	12	.0001212	1.26	....	0.80	3.16	0.96	2.20	....	....	Do.
	4.30 p. m	18	.0003307	1.26	....	0.80	3.16	0.96	2.20	....	....	Do.
	4.30 p. m	20	.0005097	1.26	....	0.80	3.16	0.96	2.20	....	....	Do.
	4.30 p. m	24	.0004290	1.26	....	0.80	3.16	0.96	2.20	....	....	No sand.
	4.30 p. m	30	.0006110	1.26	....	0.80	3.16	0.96	2.20	....	....	About one-fourth sand; the rest clay probably.
14	10.20 a. m	Surface	.0001005	1.58	Falling	1.00	3.10	1.39	1.71	0.40 a. m	1.15 p. m	Mostly a very fine sand; some vegetable and coloring matter.
	10.20 a. m	6	.0001147	1.58	....do	1.00	3.10	1.39	1.71	0.40 a. m	1.15 p. m	Clay, with very dark green coloring matter and a few grains of fine sand.
	10.20 a. m	12	.0000983	1.58	....do	1.00	3.10	1.39	1.71	0.40 a. m	1.15 p. m	Mostly very fine sand; some vegetable and coloring matter.
	10.20 a. m	18	.0003177	1.58	....do	1.00	3.10	1.39	1.71	0.40 a. m	1.15 p. m	Mostly sand, with light slate-colored matter, probably vegetable.
	10.20 a. m	24	.0003988	1.58	....do	1.00	3.10	1.39	1.71	0.40 a. m	1.15 p. m	Mostly fine sand.
	10.20 a. m	30	.0005664	1.58	....do	1.00	3.10	1.39	1.71	0.40 a. m	1.15 p. m	No sand; all clay probably.
24	1.30 p. m	Surface	.0001570	2.72	....do	0.60	2.82	1.94	0.88	9.00 p. m	7.45 a. m	A light green stain.
	1.30 p. m	6	.0001413	2.72	....do	0.60	2.82	1.94	0.88	9.00 p. m	7.45 a. m	About one-half sand; the rest clay.
	1.30 p. m	12	.0001064	2.72	....do	0.60	2.82	1.94	0.88	9.00 p. m	7.45 a. m	Green stain, with a little sand.
	1.30 p. m	18	.0001540	2.72	....do	0.60	2.82	1.94	0.88	9.00 p. m	7.45 a. m	About one-fourth sand; the rest clay.
	1.30 p. m	24	.0002247	2.72	....do	0.60	2.82	1.94	0.88	9.00 p. m	7.45 a. m	Clay, with coloring matter.
	1.30 p. m	30	.0004755	2.72	....do	0.60	2.82	1.94	0.88	9.00 p. m	7.45 a. m	Over one-half sand; the rest clay.
Oct. 3	10.00 a. m	Surface	.0002777	3.41	....do	2.50	3.66	2.37	1.29	5.00 a. m	4.45 p. m	Nearly all fine sand, about 0.002 inch in diameter.
	10.00 a. m	6	.0002337	3.41	....do	2.50	3.66	2.37	1.29	5.00 a. m	4.45 p. m	About one-half fine sand, with clay and coloring matter.
	10.00 a. m	12	.0002135	3.41	....do	2.50	3.66	2.37	1.29	5.00 a. m	4.45 p. m	Clay, with light green coloring matter.
	10.00 a. m	18	.0001861	3.41	....do	2.50	3.66	2.37	1.29	5.00 a. m	4.45 p. m	Do.
	10.00 a. m	24	.0002643	3.41	....do	2.50	3.66	2.37	1.29	5.00 a. m	4.45 p. m	All clay and coloring matter.
	10.00 a. m	30	.0004335	3.41	....do	2.50	3.66	2.37	1.29	5.00 a. m	4.45 p. m	Clay.
9	10.10 a. m	Surface	.0000729	1.55	Rising	0.40	3.01	1.30	1.71	9.10 p. m	7.35 a. m	A very light-colored green stain.
	10.10 a. m	6	.0001182	1.55	....do	0.40	3.01	1.30	1.71	9.10 p. m	7.35 a. m	
	10.10 a. m	12	.0001435	1.55	....do	0.40	3.01	1.30	1.71	9.10 p. m	7.35 a. m	A very light green stain, slightly gritty.
	10.10 a. m	18	.0001056	1.55	....do	0.40	3.01	1.30	1.71	9.10 p. m	7.35 a. m	Green stain, with a little fine sand.
	10.10 a. m	24	.0002340	1.55	....do	0.40	3.01	1.30	1.71	9.10 p. m	7.35 a. m	Clay, with light-green coloring matter.
	10.10 a. m	29	.0003428	1.55	....do	0.40	3.01	1.30	1.71	9.10 p. m	7.35 a. m	Nearly all fine sand, about 0.002 inch in diameter.
11	2.15 p. m	Surface	.0001150	1.52	....do	0.40	2.86	1.08	1.78	....	....	Greenish stain, with a little sand.
	2.15 p. m	15	.0002296	1.52	....do	0.40	2.86	1.08	1.78	....	....	Mostly fine sand, sharp and quite uniform in size, about 0.002 inch in diameter.
	2.15 p. m	29	.0002520	1.52	....do	0.40	2.86	1.08	1.78	....	....	Greenish stain, with a little sand.
15	10.15 a. m	Surface	.0001049	2.40	Falling	1.80	3.06	2.11	0.95	....	....	A greenish vegetable stain, with a few grains of sand.
	10.15 a. m	15	.0000754	2.40	....do	1.80	3.06	2.11	0.95	....	....	A greenish stain, with a little sand.
	10.15 a. m	30	.0002750	2.40	....do	1.80	3.06	2.11	0.95	....	....	Mostly fine sand, sharp and quite uniform in size, about 0.002 inch in diameter, with a light-green coloring matter.
18	10.40 a. m	Surface	.0001119	2.58	....do	1.10	2.91	2.16	0.75	....	....	Clay, with a few fine grains of sand, and containing a dark-green coloring matter.
	10.40 a. m	6	.0000994	2.58	....do	1.10	2.91	2.16	0.75	....	....	Clay, somewhat gritty, with fine grains of sand.
	10.40 a. m	12	.0001165	2.58	....do	1.10	2.91	2.16	0.75	....	....	Mostly very fine sand.
	10.40 a. m	18	.0003305	2.58	....do	1.10	2.91	2.16	0.75	....	....	A very few grains of sand, on a greenish stain.

* Sand having grains over 0.005 of an inch in diameter is called coarse. When the largest grains are less in size than this, the sand is called fine. Very fine sand indicates that the largest grains are not much over 0.001 of an inch in diameter, and from this to 0.0001 and less.

Table exhibiting the results of analysis for sediment of samples of water taken from South Pass of the Mississippi River, &c.—Continued.

Date.	Time.	Depth at which specimen was taken, in feet.	Ratio of sediment to water, by weight.	Tide.		Carrollton gauge.	Maximum and minimum reading of gauge; time and difference of same, 2.76 feet being the reading for average flood-tide.					Remarks.
							High water.	Low water.	Difference.	Time. High water.	Time. Low water.	
1877. Oct.	10. 40 a. m	24	.0004917	2. 58	Falling....	1. 10	2. 91	2. 16	0. 75	....	....	Green stain, with a little fine sand.
	10. 40 a. m.	30	.0003844	2. 58	....do	1. 10	2. 91	2. 16	0. 75	....	....	A very few grains of sand, on a greenish stain.
24	8. 10 a. m.	Surface .	.0001170	0. 88	Stationary	0. 00	3. 09	0. 98	2. 11	....	7. 50 a. m.	A very light-green stain.
	8. 10 a. m.	6	.0000892	0. 88	....do	0. 00	3. 09	0. 98	2. 11	....	7. 50 a. m.	A light-green stain.
	8. 10 a. m.	12	.0001239	0. 88	....do	0. 00	3. 09	0. 98	2. 11	....	7. 50 a. m.	A very few grains of sand, on a greenish stain.
	8. 10 a. m.	18	.0002851	0. 88	....do	0. 00	3. 09	0. 98	2. 11	....	7. 50 a. m.	A light-green stain, with clay.
	8. 10 a. m.	24	.0004273	0. 88	....do	0. 00	3. 09	0. 98	2. 11	....	7. 50 a. m.	A very light-green stain, slightly gritty.
	8. 10 a. m.	30	.0003820	0. 88	....do	0. 00	3. 09	0. 98	2. 11	....	7. 50 a. m.	Clay, with light-green coloring matter.
Nov. 3	3. 50 p. m.	Surface .	.0000663	2. 78	Rising	1. 30	2. 84	....	....	....	....	A mere stain—a light sepia color.
	3. 50 p. m.	6	.0000601	2. 78	....do	1. 30	2. 84	....	....	....	....	Clay and vegetable matter.
	3. 50 p. m.	12	.0000663	2. 78	....do	1. 30	2. 84	....	....	....	....	All clay.
	3. 50 p. m	18	.0000510	2. 78	....do	1. 30	2. 84	....	....	....	....	Clay, colored light green.
	3. 50 p. m	24	.0000747	2. 78	....do	1. 30	2. 84	....	....	....	....	Do.
	3. 50 p. m.	30	.0001362	2. 78	....do	1. 30	2. 84	....	....	....	....	Clay and vegetable matter, with about one-tenth sand.
6	10. 00 a. m.	Surface .	.0000824	1. 50	....do	1. 40	3. 13	1. 19	1. 94	....	6. 20 a. m.	Clay and vegetable matter.
	10. 00 a. m.	15	.0001524	1. 50	....do	1. 40	3. 13	1. 19	1. 94	....	6. 20 a. m.	About one-fifth sand; the rest clay.
	10. 00 a. m	30	.0003204	1. 50	....do	1. 40	3. 13	1. 19	1. 94	....	6. 20 a. m.	Over one-fourth sand; the rest clay.
12	5. 00 p. m.	Surface .	.0002505	1. 41	....do	2. 20	....	....	....	....	....	Nearly half fine sand; the rest clay.
	5. 00 p. m.	15	.0004035	1. 41	....do	2. 20	....	....	....	....	....	Over one half sand, fine and coarse; the rest clay.
	5. 00 p. m.	30	.0003959	1. 41	....do	2. 20	....	....	....	....	....	About two-thirds sand, fine and coarse; the rest clay.
16	2. 05 p. m.	Surface .	.0003319	2. 55	....do	2. 70	2. 70	2. 07	0. 63	5. 30 p. m.	1. 40 a. m	Nearly half fine sand; the rest clay.
	2. 05 p. m.	15	.0004195	2. 55	....do	2. 70	2. 70	2. 07	0. 63	5. 30 p. m.	1. 40 a. m	Over half fine sand; the rest clay.
	2. 05 p. m.	30	.0005767	2. 55	... do	2. 70	2. 70	2. 07	0. 63	5. 30 p. m.	1. 40 a. m.	About two-thirds sand; the rest clay.
21	7. 50 a. m.	Surface .	.0004381	1. 50	Stationary	3. 20	3. 49	1. 49	2. 00	7. 30 p. m.	7. 30 a. m.	About one-half sand, from 0.001 to 0.01 inch in diameter; the rest clay.
	7. 50 a. m.	6	.0004771	1. 50	....do	3. 20	3. 49	1. 49	2. 00	7. 30 p. m.	7. 30 a. m.	Over one-half sand, from 0.001 to 0.01 inch in diameter; the rest clay.
	7. 50 a. m.	12	.0005395	1. 50	....do	3. 20	3. 49	1. 49	2. 00	7. 30 p. m.	7. 30 a. m.	Do.
	7. 50 a. m.	18	.0005377	1. 50	....do	3. 20	3. 49	1. 49	2. 00	7. 30 p. m.	7. 30 a. m.	About two-thirds sand, fine and coarse; the rest clay.
	7. 50 a. m.	24	.0005600	1. 50	....do	3. 20	3. 49	1. 49	2. 00	7. 30 p. m.	7. 30 a. m	Over two-thirds sand, fine and coarse; the rest clay.
	7. 50 a. m.	30	.0005672	1. 50	....do	3. 20	3. 49	1. 49	2. 00	7. 30 p. m.	7. 30 a. m.	More than three-fourths sand, fine and coarse; the rest clay.
24	2. 25 p. m.	Surface .	.0003645	1. 68	Rising	2. 90	3. 06	1. 07	1. 99	10. 40 p. m.	9. 15 a. m	A trace of sand; the rest clay.
	2. 25 p. m.	15	.0004099	1. 68	....do	2. 90	3. 06	1. 07	1. 99	10. 40 p. m.	9. 15 a. m	About one-tenth very fine sand.
	2. 25 p. m.	30	.0006517	1. 68	....do	2. 90	3. 06	1. 07	1. 99	10. 40 p. m.	9. 15 a. m	About one-fourth fine sand; the rest clay.
27	9. 00 a. m.	Surface .	.0003017	1. 53	Falling....	2. 90	2. 88	1. 37	1. 51	1. 55 a. m.	0. 10 p. m.	About one-tenth sand, fine and coarse; the rest clay.
	9. 00 a. m.	15	.0003790	1. 53	....do	2. 90	2. 88	1. 27	1. 51	1. 55 a. m	0. 10 p. m.	A trace of sand; the rest clay.
	9. 00 a. m.	30	.0004601	1. 53	....do	2. 90	2. 88	1. 37	1. 51	1. 55 a. m.	0. 10 p. m.	Do.

Near the bottom of page 26 in my report dated August 1, 1877, occurs the following passage:

A comparison of this chart (June, 1877) with that of the survey of June 20 to 24, 1876, reveals the following regarding various curves of equal depth: Averaging, the 20 feet curve has receded about 200 feet; the 30 feet curve about 300 feet; the 40 feet has remained nearly stationary on the whole.

This should have read, and in my original notes as well as in the revised manuscript of the report it reads, "Averaging, the 20 feet curve has receded about 200 feet; the 30 feet curves *advanced*," instead of *about*, "30 feet" instead of 300 feet.

The fact of the advance or recession of the 40 feet curve, and all lines of equal depth seaward of this between the dates of any two charts, may readily be ascertained by tracing both curves on the same sheet, and carefully balancing the areas between the two curves where the depth has increased, with those where the depth has diminished; and if the excess of square contents in favor of one date is divided by the approximate length of a mean curve, the approximate advance or recession is known.

But the 30 feet curves are on all the charts quite irregular, and there are several surrounding shoals not far from the ends of the jetties, in addition to the main curve nearer the jetties.

Most of these have existed for years, but the size and shape of the areas inclosed by them is constantly changing, and after a considerable rise or fall of the river, or other radical alterations in controlling conditions, changes in the size, shape, and location of these areas are often rapid and great.

For the 30 feet curves, a comparison by balancing areas as stated is certainly too inexact, and in this case the curves are so complicated that I am not satisfied with the result obtained, and I have therefore made another computation, for the *main* 30 feet curve only, by measuring ordinates rectangular to their base, and 50 feet apart. They are nearly parallel to the general direction of the last chords of the jetties, and the origins whence measurements are made are on a right line passing through pile 1,062, east jetty, drawn with a right angle with another straight line joining pile 304, west jetty, and the old end of the west jetty at pile 355.

But first, the main 30 feet curves on the two charts must be made equitably comparable by closing that one on the chart of 1877, just southeast of the sounding, 28.7 feet, which is 600 feet beyond a point midway between the old ends of the jetties, and also by joining with the main curve the irregularly circular 30 feet curve southeast of the end of the east jetty, on the chart of June, 1876, by a neck about 100 feet wide, southeast of the three soundings 20.5, 23.0, and 24.0, which are in a right line. If the soundings were plentiful enough these changes would doubtless appear, and it had been better, in the absence of soundings instrumentally located, if the curves at these places had not been drawn continuously, in any manner, in either case.

The fairness of these changes will be manifest to any one making the comparison.

The mean value of 67 ordinates, obtained by making the necessary reductions for re-entrant portions of the curves, shows an advance of the main 30 feet curve, from June 20 to 24, 1876, to June 20 to 22, 1877, of 110 feet.

If we consider only that portion of the curve included between the prolongations of the jetties, the advance in the year was 129 feet. The same process shows that the corresponding or middle part of the 20 feet

curve receded in the same interval, 194 feet. It is necessary to state, however, in this one special instance, involving the position of the 20-feet curve June 20 to 22, 1877, that this position is not so exactly determinable as is desirable, for, when the soundings located by transit-readings had been platted, they were found to be too few to establish accurately the *entire* middle portion of the 20 feet curve, and, for the purpose of former and the present comparisons, they were supplemented by personal knowledge of the position of the curve, derived from desultory soundings made at the time, before and after the instrumental work of the day. But the curve was not completed on the chart. The amount of error for the mean ordinate of the whole curve is doubtless much less than 15 feet, judging from another partial survey made two days earlier.

Knowledge of ranges and of the position of piles will enable a surveyor making a simple hydrographic inspection, by rapidly sounding, to approximate closely to the position of the 20 feet curve, especially if he has been intently watching the movements of the crest of the bar.

Nevertheless, that no unnecessary vagueness may become attached to important data, in the future table I have marked the ordinate in question as doubtful; and in the third curve, on sheet No. 4, exhibiting the mean positions of the limited 20 feet curve, a second partial curve is drawn in the place proper for eliminating the influence of this one ordinate on the curve in question.

These explanations have been made from a due regard for accuracy, but it is incumbent on me to state that nothing important can be inferred certainly and with fairness from a comparison simply of the position of either the 20 or 30 feet curve at epochs taken at random.

If an inference, carrying with it important consequences, is to be drawn from a comparison, the epochs of the surveys must be so chosen that the conditions determining the advance and recession of the crest of the bar shall be nearly identical in each case, or else due weight must be given to the effect of all these functions.

The ratio of sand and of sediment to water, which are often subject to very considerable and sudden variations, the reading of the Carrollton gauge, the tidal conditions, the direction and velocity of the wind, and the activity of the waves, must be nearly the same, not only at the several selected epochs, but also for many days, and, in cases, even weeks previously, if the mere fact of either an advance or a recession is to conclude any deduction.

The position of the crest of the bar and the inclination of its slope are important phenomena which I must present in each report.

But to draw weighty consequences therefrom we must have before us a series of results prolonged over a considerable period of time, supplemented by detailed information concerning the main controllin conditions at each epoch.

For the table which is given below, I have measured in each instance 21 or 67 ordinates, the number depending on the length of that portion of the curve considered.

The ordinates are drawn as I have previously described.

Of the 20 feet curve only that portion embraced within the prolongation of the lines of the jetties is considered.

Those parts to the east and west of the jetties are affected by the general filling or land-making process which, with an exception heretofore noted, has been observed behind each jetty, but more especially westward of the west jetty since the works were inaugurated.

This shoaling is so far advantageous that it greatly protects the

jetties from the effects of storm-waves, and it tends to fill the lower mattresses with silt, thus rendering them more impervious to water, and enabling them more thoroughly to confine the river-flow, on which the scouring action over the bar depends. The shoaling on the flanks of the jetties is thought to be due in great part to the sediment carried thither in water which escapes over and through the jetties, and not principally, probably, to sediment which has once passed the jetties' ends.

According to results obtained by gauging the pass at times of neap tides, at least 20 per cent. of the water, passing the lands' end at East Point, escapes over the jetties and through the meshes of the mattresses at average flood-tide.

The 20 feet curve has rarely been traced far from the jetties on either side. The time required to make a complete survey, and to reduce it to charts and a report, is so long, and so much bad weather interrupts the field-work, that the less important areas must be neglected to prevent the data from becoming antiquated at the date of its publication.

But on the Coast Survey chart of May and June, 1875, and my own of June 22, 1876, and June 22 to 24, 1877, about 3,350 feet of the 20 feet curve are available, and if this is *all* considered, the comparison by ordinates shows an advance of 82 feet from June, 1875, to June 22, 1876, and a recession of 29 feet in the ensuing year, with a possible diminishing error; in the latter case of 15 feet, or a possible recession in the year of 14 feet only.

For the reasons above given I have taken into consideration in all tables, and in all comparisons other than the one just made, only the soundings and curves of "the bar and Gulf beyond the ends of the jetties," as is stated in my last report.

Table showing at various dates the mean position of that middle portion of the 20 feet curve (1,050 feet wide), nearly included between the lines of the South Pass jetties at their ends, or between their prolongations. The line from which the lengths of rectangular ordinates are measured passes through pile 1,062, east jetty, 11,551 feet from East Point, and forms a right angle with the line joining pile 304, west jetty, and the old end of the west jetty.

Date of soundings determining 20 feet curve.	Length of mean ordinate, in feet.	Mean advance of 20 ft. curve since previous date, given in feet.	Total advance since June, 1875, in feet.	Mean recession of 20 ft. curve since previous date, given in feet.	Total recession since June, 1875, in feet.	Authority for soundings which determine 20 ft. curve.	Reading of Carrollton gauge.	Mean ratio of sediment to water for one week before date of sounding.	Ratio of sand to water for one week.	General condition of weather for one week previous to the date of soundings.
June, 1875	422	......	......	......	......	Asst. Marinden, U. S. Coast Survey.	10.60	......	......	Generally pleasant, with light winds, variable from S. E. to W. S. W.
Oct. 14, 1875	485	63	63	......	......	Capt. M. R. Brown, Corps Engineers, U. S. A.	4.86+	......	......	Generally clear; two cloudy days; winds light, variable from N. E. to N. W.
Feb. 7, 1876	497	12	75	......	......	...do	9.78+	......	......	First four days light southerly winds and fog; one day heavy showers followed by strong N. and N. E. wind and clear, cold weather.
May 3, 1876	745	248	323	......	......	...do	11.95	......	......	Generally clear; wind moderate to fresh from S. E. to westerly.
June 13, 1876	609	......	187	136	......	...do	11.61	......	......	Generally clear; one day showery, wind light to moderate, variable from E. to S.
June 22–24, 1876	686	77	261	......	......	...do	10.90	......	......	Generally clear; light N. E. winds, changing to S. E.
Aug. 14–17, 1876	704	18	282	......	......	...do	7.92	......	......	One day showery, remainder clear; wind S. E. to S. W., variable.
Nov. 10, 1876	306	......	......	398	116	...do	1.30	......	......	Changeable, clear, and cloudy; wind fresh from N. to S. E., variable; one day squally, from E. S. E.
March 2, 1877	430	124	8	......	......	...do	5.30	......	......	Generally clear and pleasant; one day rainy; wind S.; generally fresh breeze.
March 15, 1877	405	......	......	25	17	...do	2.40	.0002066	Too slight to be est'd.	Changeable, clear and cloudy, showery and foggy; wind moderate to strong from S. S. E. to northing, variable.
May 10, 1877	565	160	143	......	......	...do	10.64	.0006666	.0001111	Changeable, clear, cloudy, and foggy; two days heavy showers; moderate wind, variable, from all directions.
June 22, 1877	492!	......	70	73	......	...do	10.77	.0008497	.0001104	Changeable, clear, cloudy, and squally; one day heavy showers; moderate wind, variable from E. to S. W.
July 23, 1877	779	287	357	......	......	...do	8.94	.0010717	.0009318	Generally rainy and foggy; wind variable from N. W. to E. S. E., varying in force from light to strong.
Aug. 30, 1877	658	......	236	121	......	...do	1.15	.0002088	.0000137	Generally clear; two days cloudy with showers; wind light from E. N. E. to S. W.
Sept. 21, 1877	497	......	75	161	......	...do	1.67+	.0002660	.0001409	Three days partly cloudy, with light southeasterly winds increasing to a violent storm; on the 4th easting; three days changing gradually from S. E. to N. N. W., and dying to a moderate breeze; cloudy and some rain.
Sept. 28, 1877	425	......	3	72	......	...do	0.82+	.0002098	.0000482	Clear and cloudy, with some showers; wind moderate from N. N. W. to E. S. E.
Oct. 31, 1877	249	......	......	176	173	...do	1.24+	.0002358	.0000015	Changeable, clear, and cloudy, with some rain; wind variable from all points east of N. and S.; four days squally; three days light breeze.
Dec. 1, 1877	273	24	......	......	149	...do	2.99	.000[illegible]294	.0000450	Generally clear; wind variable from N. W. to N. N. E.
Dec. 15, 1877	261	......	......	12	161	......	......	......	......	Weather variable, clear and cloudy; light winds from E. to N. E.

Table showing at given epochs the mean position of that middle portion of the main 30 feet curve, 1,050 feet wide, included between the prolongations of the South Pass jetties. Ordinates measured as stated in caption of previous table.

Date of soundings determining 30 feet curve.	Length of mean ordinate, in feet.	Advance of 30 feet curve since previous date, given in feet.	Total advance since June, 1875, in feet.	Recession of 30 feet curve since previous date, given in feet.	Total recession of 30 feet curve since June, 1875, in feet.
June 6, 1875	770	....	....	....	....
October, 1875	605	....	....	165	165
February 7, 1876	737	132	132	....	....
May 3, 1876	845	108	75	....	....
June 13, 1876	785	....	15	66	....
June 22 to 24, 1876	825	40	55	....	....
August 14 to 17, 1876	871	46	101	....	....
November 10, 1876	917	46	147	....	....
February 20, 1877	905	....	135	12	....
March 15, 1877	876	....	106	29	....
June 22, 1877	954	78	184	....	....
July 28, 1877	1,012	58	242	....	....
August 30, 1877	905	....	135	107	....
September 21, 1877	910	5	140	....	....
September 28, 1877	895	....	125	15	....
October 31, 1877	869	....	99	26	....
December 15, 1877	878	9	108	....	....

Table showing at given epochs the mean position of the main 30 feet curve, in the Gulf of Mexico, just seaward of the ends of the South Pass jetties, embracing the 1,050 feet which is the subject of the data in the preceding table, and also the portion of the curves included within 1,150 feet to the eastward and westward respectively of this middle portion. Ordinates measured as for the two previous tables.

Date of soundings determining 30 feet curve.	Length of mean ordinate, in feet.	Advance of 30 feet curve since previous date, given in feet.	Total advance since June, 1875, in feet.	Recession of 30 feet curve since previous date, given in feet.	Total recession of 30 feet curve since June, 1875, in feet.
June, 1875	656	....	....	....	....
June 22 to 24, 1876	628	....	....	28	28
August 14 to 17, 1876	708	80	52	....	....
February 20, 1877	718	10	62	....	....
June 22, 1877	738	20	82	....	....
December 15, 1877	602	....	....	136	54

In each of the above tables I have given, as well as mean, data indispensable for proper appreciation of the mean positions of the curves at the various dates of surveys.

When the ratios of sediment, &c., given depend on less than two days' sets of samples of water, that fact is stated. A detailed analysis of these samples for the period included between March 5 and November 27, 1877, will be found in this report and in the report dated August 1, 1877.

Several samples taken at short intervals vertically in the same place in the pass, usually form one set.

Where only one or two samples were taken, the mean ratio is deduced by using the ratio of the mean ratio to that ratio corresponding to the depth or depths of the single or few specimens.

In order that certain data derived from these tables and the sedi-

ment-table may be graphically presented, I have given on sheet No. 4 certain curves. The second and third show the amount of advance or recession of those portions of the 30 and 20 feet curves which are directly and principally affected by the varying conditions of the river's flow; that is, of those parts of the curves which are swept over by the discharge from the ends of the jetties, as it begins to lose its velocity in joining the waters of the Gulf.

The fourth curve gives the fluctuations and oscillations in the reference of the surface of the river as recorded officially on the Carrollton gauge; and lower are curves giving the ratios of sediment and sand to water at the several dates which form the abscisses of the curves.

The mean of all mean results in one week gives a single point of these curves. But the ratios in the table relate to sediment in suspension. The sediment (probably mostly sand) which is borne along on and near the bottom is thought to bear to the formation and continuance of the superstructure of a bar a relation so important that, in computing the ordinates for the sand-curves, 11 per cent. is added to the ascertained ratio in order to include this lowest stratum.

To the ratios of sediment 15 per cent. is added, 4 per cent. being an allowance for the deficiency occasioned by considering samples of water as though taken from the bottom, although they are in reality obtained at from two to five feet above the bed of the river, in order to avoid a disturbance of the mud or sand of the bottom.

Humphreys' and Abbot's Mississippi Report is the authority whence the percentage of sand not strictly in suspension (11) is taken. The method used to ascertain the ratio of sand and of sediment to water is described in my last report.

Unfortunately, the data relating to the ratio of sediment and of sand to water is limited to the short interval since an appropriation was made enabling the officer in charge to employ sufficient labor, and to buy the necessary means for the prosecution of the work. Inasmuch as the data are fairly elaborate for a few months only, it is not logical to draw any certain general conclusion therefrom.

So far as we have detailed information the sediment-curves conform generally in shape, but with remarkable deviations in detail, to that showing the rise and fall of the river at Carrollton, and the dependence of the one showing the advance of that portion of the 20 feet curve just outside of the jetties on the three curves next lower is marked, although many important points in the 20 feet curve are missing. The highest maximum point of the 20 feet curve is exactly synchronous with the highest point of the sand-curve.

It is seen that a considerable rise or fall in the river is connected with an increase or decrease of the ratio of sediment and sand to water, and also with the advance or recession of the 20 feet curve beyond the ends of the jetties.

But, as might have been anticipated, the maximum and minimum points on the curves are not always closely synchronous. It is also apparent that great variations are found in the ratio of sediment and of sand to water throughout periods characterized by little or no change in the stages of the river at New Orleans. The affluent which contributes most powerfully to a rise in the river at New Orleans undoubtedly determines to an important extent the amount and character of the sediment passing the jetties' ends, and therefore the advance of the 20 feet curve, and the difficulty encountered in an effort to keep the channel open.

It is noticeable that from June 10, 1875, to May 3, 1876, during which

period we have little information as to sediment and sand, the 20 feet curve constantly advanced, notwithstanding that the Carrollton gauge showed several fluctuations in the height of the river with two or, it may be said, three maximum, and the same number of minimum points in the water-level curve.

During this time the jetties were being rapidly built forward and upward toward the surface, and probably the first marked influence of the progress as a result of the scour induced is seen in this advance of the crest of the bar even when the river was steadily declining.

The first mattresses near to and beyond the present ends of the jetties, were placed in position November, 1875, and the last one beyond the present end was laid down about May 25, 1876.

Most of these mattresses rapidly sank into the bottom, and the effectiveness of all beyond the present ends of the jetties was speedily lost by depression in the mud. Then the 20 feet curve began to show its normal dependence on the existing stage of the river and on other conditions.

SCOUR AND FILL NEAR THE ENDS OF THE JETTIES.

Inasmuch as an advance of the 30 feet and a recession of the 20 feet curves often occur nearly simultaneously, it is important to know during what periods there has been a scour, and when a fill, just at and in advance of the ends of the jetties.

I have, therefore, computed for the epoch of each survey, giving the necessary data, the average depth and amount of water covering an area 1,000 feet square, just seaward of the present ends of the jetties. The line joining these ends forms one side of this square. The present end of the east jetty is 11,770 feet from East Point; the present end of the west jetty is 7,344 feet from its initial point.

In each case this square was first divided into 100 lesser squares, 100 feet on a side, and all soundings contained in one of these lesser squares were added together, and their sum being divided by the number of soundings, the average depth for each small square was obtained. The sum of the several means having been ascertained, the quotient of this number, when divided by the number of squares containing soundings, gives the mean depth for the whole area of nearly 23 acres. But in the survey of May, 1875, and June 22, 1877, it will be seen that the number of squares containing no soundings was much too large to enable us to place faith in the certainty of the result, as the vacant areas were not very well distributed, and therefore in each of these cases each large square was divided into ten zones of equal length and width, longest in a direction across the jetties.

Each of these zones was treated as the small squares in the other instances, and the grand mean was obtained in a similar manner. The results will be seen in a short table following the longer one. For computing scour and fill, the survey of May 3, 1876, is taken as the standard, and a scour indicates a deepening from that date to the date in question, and *vice versa*.

The chart of May 3, 1876, is the earliest in which the number of small squares, having no soundings in them, is small enough to guarantee the substantial accuracy of the result.

In the large square the soundings are distributed so differently at different dates that some of the results in the table may be in error by the considerable fraction of a foot; for the transition from one depth to another, much less or greater, is very abrupt over many parts of this area at times, and the table is only given as the best practicable data

at hand. It does not show any regular and exclusive dependence on the Carrollton water-level curve, and those showing the advance of the 20 and 30 feet curves, and the ratios of sand or sediment to water. Other conditions, such as the position of the 35 and 40 feet curves, and more especially the state of the weather and the frequency of violent storms, may have here a large measure of control.

The latter consideration does sometimes affect very greatly the positions of the 20 and 30 feet curves, especially at low river after the high stage has subsided.

The first curve, on sheet No. 4, is derived from the tables given below.

The following table gives a comparison of the quantities of water in an area containing 1,000,000 square feet=22.95 acres, immediately seaward of the present ends of South Pass jetties, based on charts of surveys made at various epochs:

Date of survey.	Mean depth, in feet.	Cubic yards of water overlying area.	Number of soundings in area.	Number of squares containing 10,000 square feet having soundings in them.	Number of squares containing 10,000 square feet having no soundings in them.	Excess in favor of each survey as compared with that of May 3, 1876, in cubic yards.
United States Coast Survey:						
June, 1875	25.07	....	33	33	67	....
United States Engineers:						
May 3, 1876	21.21	785,555	243	94	6	....
June 22 to 24, 1876	24.70	914,814	141	86	14	129,259
August 14 to 17, 1876	26.58	984,444	166	86	14	198,889
November 10, 1876	25.29	936,666	146	92	8	151,111
March 15, 1877	26.85	994,444	242	94	6	208,889
June 22, 1877	27.87	....	50	44	56	....
July 28, 1877	23.61	874,444	262	93	7	88,889
August 31, 1877	24.39	903,333	214	81	19	117,778
September 21, 1877	25.85	957,777	271	84	16	172,222
September 28, 1877	26.10	966,666	274	88	12	181,111
October 31, 1877	29.11	1,078,148	217	89	11	292,593
December 15, 1877	28.66	1,061,481	163	84	16	275,926
United States Coast Survey:						
June, 1875	25.91	959,269	33	9	1	174,074
United States Engineers:						
June 22, 1877	27.55	1,020,370	50	10	0	234,815

Before leaving the subject of these curves, I repeat a remark made in my last report, to the effect that the proportion of sand contained in samples of sediment is only approximately determined by my personal judgment, aided by the microscope.

In measuring the ordinates of the 20 and 30 feet curves, all portions on the positive side of the base, traversing water deeper than that indicated by the designation of the curve are rejected, and the same principle is applied inversely for negative ordinates. In this manner all shoaling and all scour is considered, if it affect the main curve.

But isolated lumps beyond the main curve are not considered.

BEYOND THE JETTIES, IN DEEP WATER.

As considerable attention has been directed to a table on page 30 of my Report, dated August 1, 1877, giving data as to the amount of scour and shoaling in an area of about $1\frac{1}{4}$ square miles beyond the jetties' ends, it may be well to make an explanation regarding division 1 of that area, which, it has been contended by some, should not have been included in the general averaging, because the soundings were but 8 in

number in June, 1877, and 6 in June, 1876. Doubt as to the alleged shoaling has been expressed.

Had it been practicable, more soundings would have been made in this area, but bad weather and other causes induced me not to prolong the survey for the purpose. For it is evident that one single sounding here is much more valuable in determining the mean depth than several near the ends of the jetties, because of the greater uniformity of slope and the absence of abrupt changes of depth and of the character of the bottom; and again, the existence of the shoaling shown in division 1 by comparing the two charts designated was well known to me and all of my party and to others.

The amount of shoaling, 11.7 feet, is corroborated by an inspection of the following table.

Mean depths at various dates in division 1 of sheet No. 3, seventh report on the improvement of South Pass, by Capt. M. R. Brown.

Date of chart.	Number of soundings in division 1.	Average depth, in feet.
June 20 to 22, 1876	6	98.00
August 14 to 17, 1876	16	92.09
February 21, 1877	22	89.86
June 20 to 24, 1877	8	86.30

It is here seen that the shoaling in this division has been progressive, although not uniform in rate. But uniformity of rate throughout the varying phases of the river, and under the changed conditions brought about by building up the jetties, is not to be expected.

The fact of the shoaling is sufficiently evident.

THE "TEREDO NAVALIS."

From the first, care has been taken to gather evidence bearing on the liability of willows to ravages from worms, and on the rapidity with which pine and willow wood is destroyed by these creatures, when subjected to the peculiar conditions presented at different points along the jetties.

Various reports had reached me of worm-eaten willows, of small diameter, taken from the water and mud at the mouth of the "Jump" and elsewhere. But, although many inspections had been made with a view to the detection of possible worms or their work, no evidence of their presence in the jetties was obtained until about December 4, 1876, when a pile, broken off ten feet from its top, at a place where worms had eaten much of the wood, was found on Pelican Island. This pile had probably been driven in one of the jetty-lines within six months. At the same time and place several willows much eaten by worms were found. One of these, completely "honey-combed," was about nine feet long, one and one-half inches in diameter at the butt, and perhaps half an inch in diameter at the smaller end.

During the hurricane, December 31, 1876, a pile lodged near East Point by the reflux current had been broken off, where the effect of worms was most evident, 11 feet 6 inches below the plane of average flood-tide. It was eaten to its center to a "honey-comb." The worms

had worked to within about 5 feet of average flood-tide. It was not determinable precisely whence this pile had come. Another pile found on the same day at station 62, west jetty, had one of my reference-marks on it. It bore also the station-mark "115." It came, therefore, from the east jetty, 11,500 feet from East Point. It was broken off 5 feet below average flood-tide, and the worms had worked barely perceptibly within 2 feet 3 inches of the same plane. They had penetrated to the center, where the fracture had occurred. This pile was driven in April, 1876.

During an inspection for worms and their traces, January 22, 1877, at a point 11,740 feet from East Point in the east jetty, an affected willow-sapling was found, with its butt end about 2½ inches in diameter, afloat. Its smaller end, ¾ of an inch in diameter, was connected, 9 feet under water, to a subsurface mattress, as though it had formed a part of the mattress, and it required to be violently fractured at its junction with the mattress in order to secure it. At the larger end worms were found, and half-way down, but nowhere else. It was evident that it had occupied some position primarily, quite different from that in which it was found, and it was surmised that it had sprung to the surface after having parted at the worm-eaten section, which was uppermost when found. At 11,700 feet from East Point a piece of a mattress-binder somewhat worm-eaten was picked up from the jetties; it came from a mattress which had been in the top tier. Several other specimens were discovered at about the same date, some very slim willows, all more or less teredo-eaten, but all coming from near the ends of the jetties.

The details of some of the earlier quests are given, but it is sufficient of later investigations to say that at different times pieces of willows of the various sizes, parts of mattress-frames and of piles, have been discovered on the jetties and near them, more or less eaten by the teredo, and some as completely disintegrated as any I have ever seen.

In a recent search, several pieces of willows and binders have been hooked up from a locality about 50 feet beyond the present end of the east jetty, in about 17 feet of water. Some of these were thoroughly permeated by worm-holes, and others were but slightly affected. As considerable stone and *débris* lay on the surface of the submerged mattress it is impossible to know whether the sounder specimens recovered were from a mattress originally placed here, or were parts of surface-mattresses higher up in the jetties and driven thither during storms which made partial wrecks of some of the mattresses.

The willows from beneath the water were all of greater specific gravity than the water itself, and sank readily, even in salt-water. It is only during low river that the water at the ends of the jetties is salt at or near the surface. The mattress last referred to, in water 17 feet deep, was sunken in May, 1876.

It appears from all that has been ascertained that only the ends of the jetties are liable to speedy damage from worms, excepting possibly parts surrounded by water over 5 feet deep. The season during which worms could work above 10,000 feet from East Point is much shorter than at the extreme ends of the jetties, as the water near the surface is seldom very salt long at a time, and the shoal water behind the jetties and near them, between the wing-dams, insures comparative immunity for the upper part of the jetties.

So far as can be judged at present, no considerable damage from worms need be anticipated above a point 10,200 feet from East Point.

Some specimens at the ends of the jetties were so much affected that no sound material sufficient for the worms to live in and bore their holes

in the usual manner was present, apparently. In some instances where this occurred one end was only partially eaten, and here the worms were found alive, while in the more completely affected portions no worms, dead or alive, could be discovered.

The teredo seemingly works along through a willow lengthwise of the grain, in all cases, although the small holes, no larger than a pin's puncture, where the worms had entered when young, are to be found over the surface at places.

The avenues made by the worms finally leave the willows a compact mass of nearly parallel tubes, lined in many places with a calcareous substance which seems to be of the nature of the worm's borer at its head, and much like a thin shell. This seems to lend some degree of toughness and strength to the damaged wood, and after one or two seasons of concentrated work in some pieces, during which their utmost injury seems to have been effected by worms, considerable strength and power of coherence still remained to the willow-wood, so long as moderate pressure only was applied, but a blow with the hand or an instrument easily shattered the specimens.

Where considerable sediment has settled on either flank of the jetties, the mattresses are mostly filled with mud and sand to a level with that outside, and in these parts the jetties are perhaps protected from worms by this circumstance, for all the specimens of wood I have seen, known to have been completely buried in the mud, are entirely free from worms or their traces.

The manner in which the jetties are built, the effects of storms in covering accessible mattresses with *débris*, and the great weight of water-soaked willows, causing them to sink, as well as deposits of mud, &c., over some mattresses, all combine to make it a difficult task to obtain specimens of mattresses sunk a year or more previously.

It is impracticable to determine whether or not any part of the subsidence of the upper surface of the jetties is due to a compression of partially disintegrated willows.

The present piles along the jetty-lines are comparatively new, the old ones having been cut off near the water-surface, but none of the old ones above station 112 are known to have disappeared after becoming worm-eaten.

DEPRESSION OF THE JETTIES BY SETTLING, AS A WHOLE, AND BY COMPRESSION.

The amount of settling of the ends of the jetties from May 23 to July 24, 1877, had been much less than in previous equal periods, and only appreciable by leveling. Until the fall storms began, no new settlement occurred important or perceptible in amount.

The vibration, especially of the ends, of the jetties is very marked whenever the waves are powerful and come broadside on the jetties.

It is to be expected, therefore, that more settling, and perhaps more compression, will occur in stormy seasons than during continued calm weather, and the late storms are the first of great violence that the jetties have experienced since considerable quantities of stone were placed on them.

On the 26th of October a series of levels was taken over the jetties, and these are compared in the following tables, with the references of the top surface July 24, in the following manner: The mean of the elevations at the sea and river edges, respectively, and at the axial or middle line of the mattresses, was taken for each date as a single elevation,

once in each length of 100 feet, unless some abnormal depression or lump interfered, when the nearest characteristic spot was selected. The mean of all the averages in each section 1,000 feet long gives the accepted mean elevation for the section.

Where loose willows have been very recently loaded with stone a reasonable amount is deducted for expected and desired compression, such as occurs nearly at once in such cases.

The tables show that, in an interval of about three months, the upper surface of the east jetty became depressed about one foot and one-third. In Kipp dam and the west jetty the depression was about one foot. It cannot be ascertained accurately how much of this is due to actual subsidence and how much to compression of the willows and mattresses. The one or two tiers which can be reached for measurement are in good part arranged to allow the mattress-binders to become pressed down on the willows by the weight of the stone superposed. In some places the binders are found pressed down considerably, but not always, and for this reason portions of the upper tiers are irregular in thickness between the binders.

The willows that have been placed on the jetties and covered with stone often become pressed into the mattresses, and the mattresses themsolves are considerably lower in the middle thad at either edge. Again, the warping of mattresses, to which the sun and storms greatly contribute, leaves doubt as to what is the mean thickness of an upper mattress, and as only the upper tiers can be accurately measured, even a close approximation to the aggregate compression is out of the question. From East Point to a point 2,000 feet below it on the east jetty, the great weight of stone temporarily placed on the jetty for want of more convenient storage-room must account for at least a part of the depression here.

On sheet No. 4 may be found a graphical representation of the elevation of the outside, middle, and inside lines of the upper surface of the end of the east jetty May 23 and October 26, 1877. For each of these profiles a determination of level was made once each 50 feet from 10,200 feet from East Point to 10,600 feet, and once each 25 feet thence to the jetty's end. But on October 26 so much of the edges of the old upper surface was under water or otherwise covered and broken that levels could not be well determined frequently at the edges, and therefore the lower parts of the outside and inside profiles for October 26 are incomplete on the diagram.

From an inspection of the various cross-sections through the jetties given in successive reports from time to time, the combined sinking and compression at several points between different dates may be easily ascertained.

The depression of the upper surface of the jetties has been established from bench-marks on the oldest and best-settled piles. Bad weather and occupation on other important details have prevented a series of levels completely connected throughout. If it is discovered hereafter that the bench-marks also have settled, the amount of their respective settlement must be added to that already determined. But the uniformity of apparent levels above 11,000 feet from East Point and the corresponding point on the west jetty indicates that the amounts given are, with slight changes, the greatest likely to be ascertained for the period in question for all except the lower 1,800 feet of the jetties.

Comparative references of successive sections of 1,000 feet of the upper surface of the west jetty, July 18, 1877, and October 31, 1877, respectively, showing subsidence of the jetty, including compression of willows and mattresses not newly placed.

Distance from pile No. 1, in feet.	Mean reference to the plane of average flood-tide, July 18, in feet.	Mean reference to the plane of average flood-tide, October 31, in feet.	Excess in favor of July 18, in feet.
0 to 1,000	2.00 + above	0.88 above	*1.12
1,000 to 2,000	1.48 above	0.46 above	*1.02
2,000 to 3,000	1.09 above	0.46 above	0.63
3,000 to 4,000	0.12 above	0.87 below	0.99
4,000 to 5,000	1.80 above	0.55 above	1.25
5,000 to 6,000	1.97 above	0.30 above	1.67
6,000 to 7,000	1.19 above	0.22 below	1.41
7,000 to 7,385	1.40 above	0.27 below	1.67

*0.50 foot to be allowed for compression of loose willows newly placed in calculating mean subsidence. Mean subsidence of west jetty = 1.091 feet.

Comparative reference of the upper surface of Kipp dam, July 18, 1877, and October 31, 1877, respectively, showing subsidence of the dam, including compression.

Mean reference to the plane of average flood-tide, July 18, in feet.	Mean reference to the plane of average flood-tide, October 31, in feet.	Excess in favor of July 18, in feet.
2.24 + above	1.27 above	0.97 +

Comparative references of successive sections of 1,000 feet of the upper surface of the east jetty, July 18, 1877, and October 31, 1877, respectively, showing changes due to storms, new work, and subsidence of the jetty, including compression.

Distance from East Point station, in feet.	Mean reference, July 18, to the plane of average flood-tide, in feet.	Mean reference, October 31, to the plane of average flood-tide, in feet.	Excess in favor of.		Addition to the mean references due to new work added since July 18.	Diminution of mean references due to storms of September 20 and October 1.	Mean depression of each section obtained by eliminating results of new work and damage from storms in changing elevations.
			July 18, in feet.	October 31, in feet.			
0 to 1,000	0.83 + above	1.95 above		1.12	2.58		1.46
1,000 to 2,000	2.02 + above	2.87 above		0.85	3.44		2.59
2,000 to 3,000	0.17 below	0.53 below	0.36				0.36
3,000 to 4,000	1.14 below	1.72 below	0.58				0.58
4,000 to 5,000	0.03 above	1.46 below	1.49			0.60	0.89
5,000 to 6,000	0.01 above	0.30 above		0.29	1.09		0.80
6,000 to 7,000	1.87 above	0.91 above	0.96				0.96
7,000 to 8,000	1.92 above	0.51 above	1.41				1.41
8,000 to 9,000	2.30 above	1.05 above	1.25				1.25
9,000 to 10,000	2.36 above	0.61 above	1.75				1.75
10,000 to 11,000	2.65 above	0.54 above	2.11				2.11
11,000 to 11,770	2.00 above	1.96 below	3.96			1.63	2.33

Mean subsidence of east jetty, obtained by eliminating results of new work and damage from storms, from July 18 to October 31 = 1.374 feet.

I subjoin here copies of statements forwarded to the following papers of New Orleans, August 30, September 29, November 1, and December 2, in pursuance of instructions from the honorable Secretary of War, that information of an exact character as to important facts regarding the depth of channel, and so forth, shall be published promptly after its ascertainment. Statements were forwarded to the New Orleans Times, Picayune, Democrat, and Price-Current.

UNITED STATES ENGINEER OFFICE,
Port Eads, La., August 30, 1877.

On the 30th day of August there was a 20 feet channel at average flood-tide, which is the same as high tide of August 30, through the bar at South Pass, and throughout the pass, and between the jetties. Its least width was 192 feet. A practicable channel of 20.8 feet was found. The interruption to navigation for a vessel drawing 22 feet was 114 feet in length.

Wherever found, that is, with the exception of the interruption above noted, the 22 feet channel was at least 130 feet wide. The space lacking a 22 feet channel of the full width of 200 feet is about 900 feet in length.

At low tide of August 30 these depths were lessened 1.1 feet. On August 29 a wide channel 22.2 feet deep in its shallowest place was found at the head of South Pass.

I certify that the above is a correct statement taken from the results of my latest survey.

M. R. BROWN,
Captain of Engineers, U. S. A.

Official. Furnished by order of the Hon. Secretary of War.

UNITED STATES ENGINEER'S OFFICE,
Port Eads, La., September 29, 1877.

On the 28th of September there was a 20 feet channel, at average flood-tide, through the bar at South Pass, and throughout the pass, and between the jetties. Its least width was 230 feet. A practicable channel of 20.7 feet was found.

The interruption to navigation for a vessel drawing 22 feet was 85 feet in length.

Wherever found, that is, with the exception of the interruption above noted, the 22 feet channel was at least 110 feet wide.

The space lacking a 22 feet channel of the full width of 200 feet is about 1,300 feet in length.

At low tide of September 28 these depths were lessened 1.5 feet, and at high tide 0.7 foot.

On September 25 a wide channel of 22.3 feet depth was found at the head of the pass.

I certify that the above is a correct statement taken from the results of my latest survey.

M. R. BROWN,
Captain of Engineers, U. S. A.

Official. Furnished by order of the Hon. Secretary of War.

UNITED STATES ENGINEER'S OFFICE,
Port Eads, La., November 1, 1877.

On the 31st day of October there was a 20 feet channel, at average flood-tide, through the bar at South Pass, and throughout the pass, and between the jetties. Its least width was 210 feet. A practicable channel of 21 feet was found. The interruption to navigation for a vessel drawing 22 feet was 430 feet in length.

Wherever found, that is, with the exception of the interruption above noted, the 22 feet channel was at least 160 feet wide. The space lacking a 22 feet channel of the full width of 200 feet is about 850 feet in length.

At low tide of October 31 these depths were lessened 0.8 foot, and at high tide 0.5 foot.

On October 24 a wide channel of 22.5 feet depth was found at the head of South Pass.

I certify that the above is a correct statement taken from the results of my latest surveys.

M. R. BROWN,
Captain of Engineers, U. S. A.

Official. Furnished by order of the Hon. Secretary of War.

UNITED STATES ENGINEER'S OFFICE,
Port Eads, December 2, 1877.

On December 1 there was a practicable channel 21.3 feet deep in its shoalest part throughout South Pass to the deep water of the Gulf at average flood-tide.

A line 22.4 feet in depth could be traced through the bar to deep water.

The 20 feet channel was 212 feet wide and the 21 feet channel 120 feet wide at the narrowest contraction of each.

The interruption to a practicable channel between 22 feet inside and the same depth outside was 90 feet in length.

At low water of the day these depths were lessened 1.6 feet, and at high water about 0.4 foot.

I certify that the above is a correct statement taken from the results of my latest survey.

M. R. BROWN,
Captain of Engineers, U. S. A.

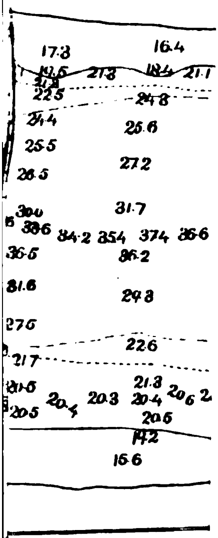
Official. Furnished by order of the Hon. Secretary of War.

The next monthly survey will be made on or about January 7, 1878, in order to divide into two nearly equal periods the interval between December 15 and January 31.

Very respectfully, your obedient servant,

M. R. BROWN,
Captain of Engineers, U. S. A.

Hon. G. W. McCRARY,
Secretary of War, Washington, D. C.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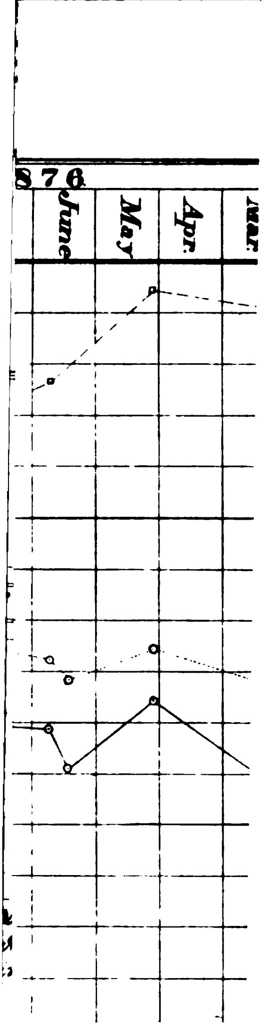
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45TH CONGRESS, } HOUSE OF REPRESENTATIVES. { Ex. Doc.
2d Session. } { No. 53.

SAINT CROIX RIVER.

LETTER

FROM

THE SECRETARY OF WAR,

TRANSMITTING

Report upon Saint Croix River.

FEBRUARY 15, 1878.—Referred to the Committee on Commerce and ordered to be printed.

WAR DEPARTMENT,
Washington City, February 13, 1878.

The Secretary of War has the honor to transmit to the House of Representatives, in compliance with the resolution of the House of the 6th instant, copy of House Executive Document No. 75, part 6, Forty-third Congress, second session, containing the latest report on the Saint Croix River; also, letter of the Chief of Engineers of the 12th instant, submitting the same.

GEO. W. McCRARY,
Secretary of War.

The SPEAKER *of the House of Representatives.*

OFFICE OF THE CHIEF OF ENGINEERS,
Washington, D. C., February 12, 1878.

SIR: I have the honor to acknowledge the reference to this office for report of the following resolution of the House of Representatives, viz:

"*Resolved*, That the Secretary of War be, and he is hereby, requested to transmit to this House, at his earliest convenience, so much of the letter of his predecessor, addressed to the Forty-third Congress, bearing date February 8, 1875, as relates to the examination and improvement of the Saint Croix River, in the States of Minnesota and Wisconsin; together with such renewed or further recommendations and other papers relating thereto as he may deem proper."

In reply I beg leave to state that, in obedience to the requirements of section 2 of the river and harbor act of June 23, 1874, an examination was made of the "Saint Croix River below Saint Croix Falls, in Minnesota and Wisconsin," and the report thereon was submitted to Congress by the Secretary of War February 8, 1875, and was printed

in Ex. Doc. No. 75, part 6, H. R., 43d Congress, 2d session, a copy of which is inclosed.

No further information in relation to the Saint Croix River has since been received at this office.

The resolution of the House of Representatives is herewith returned.

Very respectfully, your obedient servant,

A. A. HUMPHREYS,
Brigadier General and Chief of Engineers.

Hon. GEO. W. MCCRARY, *Secretary of War.*

[Forty-third Congress, second session. House of Representatives.—Ex. Doc. 75, part 6.]

Letter from the Secretary of War, transmitting reports of examinations of the Saint Croix and Chippewa Rivers.

WAR DEPARTMENT, *February* 8, 1875.

The Secretary of War has the honor to transmit to the House of Representatives, in further compliance with the provisions of the act of June 23, 1874, copies of reports of examinations of the Saint Croix and Chippewa Rivers.

WM. W. BELKNAP,
Secretary of War.

OFFICE OF THE CHIEF OF ENGINEERS,
Washington, D. C., February 5, 1875.

SIR: I beg leave to submit herewith copies of reports to this office of the examinations of Saint Croix River, from Saint Croix Falls to its mouth, Minnesota and Wisconsin; and of Chippewa River, from Chippewa Falls to its mouth, Wisconsin, made in compliance with provisions of the river and harbor act of June 23, 1874.

Very respectfully, your obedient servant,

A. A. HUMPHREYS,
Brigadier-General and Chief of Engineers.

Hon. W. W. BELKNAP,
Secretary of War.

Examination of Saint Croix River from Saint Croix Falls to its mouth, Minnesota and Wisconsin.

SAINT PAUL, MINN., *January* 30, 1875.

GENERAL: I have the honor to make the following report of an examination of the Saint Croix River, Minnesota and Wisconsin, from the Falls of Saint Croix to its mouth.

The examination was made by a party under the charge of Assistant D. H. Ainsworth.

The river was carefully examined for the whole of the above distance, and detailed surveys were made of the localities where obstructions existed.

I.—DESCRIPTION OF RIVER.

The headwaters of this river reach to within 25 miles south of Ashland, on Lake Superior, and it drains an area of quite 6,000 miles, above the Falls of Saint Croix. At the Falls of Saint Croix it falls over a trap-rock into a deep, narrow gorge, only 200 feet wide, but, a very short distance below, widens out to about 600 feet. The fall of the river in 3 miles, at Saint Croix Falls, is about 74 feet.

The width of the river below varies from 300 to 800 feet. The valley is from 800 feet to 1 mile wide, and is bounded by high, deep, rocky bluffs, their formation being soft sand-rock overlaid by limestone, the wide parts being generally low and marshy.

The only considerable tributary between the falls and the lake is the Apple River. The average river-slope from the falls to Lake Saint Croix, at low water, is .61 foot per mile. The low-water discharge, just below the falls, is about 4,000 cubic feet per second. At Stillwater the river widens out into Lake Saint Croix, which has a width of from 2,000 to 7,000 feet. The borders of the lake are high, steep bluffs of sand-rock, overlaid by limestone. There is but little difference between the levels at Stillwater

and the mouth of Lake Saint Croix—only 1 inch (October 20, 1874). The distance from Saint Croix Falls to Lake Saint Croix is 28½ miles, and from the head of the lake to the Mississippi River, 24 miles.

II.—OBSTRUCTIONS.

The obstructions to free navigation of the river are of two kinds, natural and artificial.

1. *Natural obstructions.*—The natural obstructions consist of sand and gravel bars formed in wide places in the river, some bowlders, and overhanging trees. These are remarkably few, and, for the greater part of each navigable season, there is now no trouble in navigating the river, so far as natural obstructions are concerned.

The following is the list of natural obstructions between the falls and Stillwater:

1st. From .7 to 1.2 miles below the falls is a broad channel, and a narrow one behind an island. The narrow one is used at extreme low water, but is not easy to navigate on account of boom arrangements and narrowness.* (See detail No. 1.)

2d. Foot of McLeod's Lake, 12.6 miles below the falls, sand-bar. (See detail No. 3.)

3d. Below mouth of Apple River, 20.7 miles below the falls, sand-bar, due to detritus brought down by Apple River. (See detail No. 4.)

4th. 26.6 miles below the falls, sand-bar. (See detail No. 4.)

5th. Stillwater, sand-bar at mouth of river. (See detail No. 4.)

2 *Artificial obstructions.*—These consist of boom-piers, lines of piling to carry sheer-booms, and loose logs floating down stream. There are four boom-piers 4.6 miles below the falls, and five boom-piers just above Osceola, which are very much in the way of boats. These piers are not used now for any purpose. The boom company use the river for their collecting and distributing boom-grounds, for some seven miles above Stillwater. During the early part of the season of navigation the river for about five miles of this distance is entirely filled with logs, which at times entirely prevent any navigation of the river for this distance; and, until the logs are rafted and distributed, the steamboats have to take side-channels on the east side of the river. This obstruction continues during some seasons for sixty days. Even when the booms are nearly empty the lines of piles driven to direct the logs into the booming-grounds are a great obstruction. Steamboats towing barges have great trouble in passing through the two upper intervals, as the lines of piles are nearly parallel with the current. From an inspection of the accompanying detail-tracing No. 4, it will be clearly seen how this arrangement of booming-grounds obstructs the channel of the river. On this head Assistant Ainsworth makes the following remarks:

"There is a complaint, however, on the part of steamboat-men and residents of towns above Stillwater, that navigation by boats, and the rafting of sawed lumber, is prevented by the use of several miles of river as holding for logs, after the heavy 'runs' of the early summer. The fact that about 200,000,000 feet of logs are scaled annually at Stillwater, of which one-half is sawed there and one-half rafted to points on the lake below and the Mississippi, while large saw-mills lie idle above, is evidence in justification of the complaints, as proof that lumbering is the great interest overshadowing all others, and proba bly has the active sympathy of nearly all the people of the Saint Croix Valley. The interests of the mill-owners at Stillwater and the boom corporation seem identical, and favor concentration at that point. The loggers and log-runners may be neutral, and the interests of the small towns struggle at a disadvantage."

As in other reports on rivers, where lumbering is the predominant interest, I respectfully suggest that, if the United States is to improve this river by removing natural obstructions, some provision must be made to prevent the placing of artificial ones.

Below Stillwater the only obstruction to navigation is Catfish Bar, 6 miles below Hudson. This bar is caused by the direction of the current on the east side of the lake, and the detritus brought down by Bowles Creek from the west side. There is a channel through it, but at such an angle with the general direction of the lake as to make its navigation difficult. (See detail tracing No. 6.) There is some trouble for boats in making the landing at Hudson. Just above Hudson the Willow River comes in from the east, and between its mouth and the channel is an immense sand-bar, quite bare at low water. (See detail tracing No. 5.) On this sand-bar is located a trestle-bridge of the West Wisconsin Railroad. The draw in the bridge is well located, and does as little injury to navigation as any bridge could. The point of the sand-bar is gradually extending northward, and, in time, will entirely prevent all approach to Hudson. To remedy this would require a relocation of the railroad-bridge and draw, the closing up of the present channel on the west side of the lake, and dredging out a new channel from the upper side of the bar to the east shore at Hudson, all of which would cost an immense sum, and as it does not appear that the commerce of the river, either at present or in the future, would justify any such expenditure, no plan or estimate is submitted. Eleven miles below Hudson is the Kinnikanick Bar, which is at the mouth of the river of same name, coming in from Wisconsin. There was, however,

a good channel, at least 300 feet wide and 4 feet deep, on west side of lake, and no improvement is thought necessary.

III.—IMPROVEMENTS.

The improvements required for a 3-foot channel at low-water are as follows:

1. .7 miles below the falls, 250 linear feet brush-dam, to close west channel, at $5.50 per foot		$1,375
2. 12.15 miles below falls, 100 linear feet brush-dam, at $3		300
3. 20.75 miles below falls (Apple River), 600 linear feet brush-dam, at $4.50	$2,700	
200 linear feet brush-dam, at $1.50	300	
		3,000
4. 26¼ miles below falls, 300 linear feet brush-dam, at $4.25		1,275
5. 26.73 miles below falls, 300 linear feet brush-dam, at $5.50	$1,650	
100 linear feet brush-dam, at $3	300	
		1,950
6. Delta of river just above Stillwater, 400 linear feet brush-dam, at $5.20	2,200	
100 linear feet brush-dam, at $3	300	
		2,500
7. Removing 460 cubic yards boom-pier, at $3		1,380
8. Cutting down overhanging trees		300
9. Catfish Bar, 1,400 feet wing-dams, at $5.50		7,700
		19,780
10 per cent. for contingencies		1,978
Total amount		21,758

All of the above amount can be judiciously expended in one season.

It may be that a jetty from the end of the delta toward Stillwater may become necessary to keep a good channel across the bar to the deep water in front of Stillwater

IV.—COMMERCE.

The principal interest in the Saint Croix Valley, as stated above, is the lumber-trade

All of the towns between Stillwater and the Saint Croix Falls depend largely on the river for means of transportation for persons and supplies. There is one steamer that makes daily trips during the season of navigation from Stillwater to Saint Croix Falls and return, besides which there are other steamers that make about four trips a week.

Below Stillwater there are, daily, several steamers passing up and down in connection with the lumber-trade.

There was no means of accurately determining the statistics of commerce in the valley of the Saint Croix. As before stated, about 200,000,000 feet, board-measure, of logs are annually scaled at or near Stillwater, about one-half of which are there manufactured into lumber, and the remainder rafted down stream to mills below, on the Saint Croix and Mississippi Rivers. About 4,500,000 feet of lumber are manufactured at the several saw-mills above Stillwater, a great part of which is sold in the country and the remainder rafted down the stream. There are also several flouring-mills in the valley that ship flour by the river. The population of the several towns on the river, between its mouth and Saint Croix Falls, amounts to about 15,000 people.

Very respectfully, your obedient servant,

F. U. FARQUHAR,
Major of Engineers.

Brig. Gen. A. A. HUMPHREYS,
Chief of Engineers, U. S. A.

45TH CONGRESS, 2d Session. } HOUSE OF REPRESENTATIVES. { Ex. Doc. No. 54.

ACCOUNTABILITY OF DISBURSING-CLERK OF THE INTERIOR DEPARTMENT.

LETTER

FROM

THE SECRETARY OF THE INTERIOR,

RECOMMENDING

That the disbursing-clerk of the department be relieved from responsibility of the payment of certain forged vouchers.

FEBRUARY 19, 1878.—Referred to the Committee of Claims and ordered to be printed

DEPARTMENT OF THE INTERIOR,
Washington, D. C., February 15, 1878.

SIR: I have the honor to transmit herewith the petition of Richard Joseph, esq., disbursing-clerk of the Interior Department, setting forth that during the month of September, 1877, certain vouchers, purporting to be signed by employés of the Patent Office, representing the amount of $1,167, were presented to him by Frederick R. Goodridge, a clerk in the office of the Commissioner of Patents, charged with the duty of preparing the pay-rolls and vouchers and presenting them for payment; that he paid said vouchers in good faith, and gave the money to said Goodridge for delivery to the parties entitled, as was the custom in such cases.

A few days after such payments were made it was discovered that the signatures affixed to said vouchers were forgeries, so well executed as to escape detection upon a careful examination. The vouchers were approved before payment by the Commissioner of Patents, and by the Assistant Secretary of the Interior. The said Goodridge confessed that he had forged said vouchers and appropriated the money to his own use.

Upon an indictment found by the grand jury of the supreme court of the District of Columbia he plead guilty, and was, on the 8th instant, sentenced to hard labor in the penitentiary for two years. The disbursing-clerk has paid to the persons entitled the sums obtained by Goodridge on the forged vouchers, and must, therefore, account to the government out of his own private means for the sum of $1,167. The said Goodridge had, previous to the occurrences herein referred to, borne a good reputation. The vouchers presented were properly approved. The disbursing-clerk cannot be charged in this matter with any failure to exercise proper care, or with any neglect of duty. This department has full confidence in his faithfulness and integrity. Great injustice would be done to him by holding him personally responsible for the amounts paid upon the fraudulent vouchers referred to. I therefore commend his

request to be relieved from accountability for the amount so paid, to the favorable consideration of Congress.

Very respectfully,

C. SCHURZ, *Secretary.*

Hon. SAMUEL J. RANDALL,
Speaker of the House of Representatives.

WASHINGTON, D. C., *February* 14, 1878.

To the House of Representatives of the United States:

Your petitioner respectfully shows that, on the 1st day of July, 1871, he was appointed disbursing-clerk for the Department of the Interior, and entered into ample and satisfactory bonds for the faithful discharge of his duties as such. That since that date he has so continued, and is now, in the faithful discharge thereof, having, during that period, disbursed over twenty millions of dollars of the public moneys, and accounted therefor to the complete and entire satisfaction of the proper officials of the Treasury Department.

That a part of his duties, as aforesaid, is the payment of the salaries of the employés of the department and its various bureaus and offices.

That during the month of September, 1877, last past, certain vouchers, amounting in all to the sum of $1,167, purporting to be signed by employés of the Patent Office, on account of their services, and bearing the genuine indorsement of approval, in writing, of the Commissioner of Patents and of the Assistant Secretary of the Interior, were presented to him for payment. That he, relying upon the strength and authority of such approvals, and the official and moral integrity of one Frederick R. Goodridge, a clerk in the office charged with the duty of preparing vouchers, pay-rolls, &c., and of presenting them for payment, paid said vouchers in good faith, and handed the money to said Goodridge for delivery to the said employés, as was the custom in such cases.

That, a few days subsequently to such payment, it was discovered that the signatures affixed to said vouchers, and purporting to be the genuine signatures of said employés, were forgeries, but so well and artfully executed as to confound and astonish the genuine parties themselves. That said discovery having been made, Goodridge thereupon confessed his committal of the crime, and appropriation of the money to his own use.

True bills of indictment were thereupon presented against said Goodridge by the grand jury, in the supreme court of the District of Columbia, holding a criminal term, and he was, on the 8th instant, under a plea of guilty, sentenced to the penitentiary at hard labor for the period of two years.

Your petitioner further shows that he was compelled to repay said vouchers to the genuine parties, and is therefore obliged to account to the government out of his private means, for the sum of $1,167 so repaid.

He therefore prays that he, being innocent of any laches or neglect, and having relied upon the authority, in writing, of the Assistant Secretary of the Interior and the Commissioner of Patents in the original payment of said vouchers, ought not to be held accountable to the United States for the sum aforesaid. To the end, therefore, that appropriate legislation may be had to relieve him from such accountability, your petitioner now and will forever humbly pray.

RICHARD JOSEPH,
Disbursing-Clerk Department of the Interior.

O

DISTRIBUTION OF UNITED STATES TROOPS.

LETTER

FROM

THE SECRETARY OF WAR,

SHOWING

The distribution of United States troops.

FEBRUARY 19, 1878.—Referred to the Committee on Military Affairs and ordered to be printed.

WAR DEPARTMENT,
Washington City, February 18, 1878.

The Secretary of War has the honor to transmit to the House of Representatives, for the Committee on Military Affairs, in response to the request of Hon. Levi Maish, of said committee, a report of the Adjutant-General, of this date, and the lists submitted by him, showing the distribution of United States troops, staff officers of the Army, with their stations, and officers of the line detailed for staff duty, how and where employed, on the 30th of June, 1877.

GEO. W. MCCRARY,
Secretary of War.

To the SPEAKER *of the House of Representatives.*

HEADQUARTERS OF THE ARMY,
ADJUTANT-GENERAL'S OFFICE,
Washington, February 18, 1878.

SIR: In answer to the letter of the Hon. Levi Maish, acting chairman of the Committee on Military Affairs of the House of Representatives, dated the 31st ultimo, and referred to this office for report, I have the honor to inclose herewith the following statements, viz:

1st. Distribution of United States troops in the several military divisions and departments on the 30th day of June, 1877.

2d. List of staff officers of the Army, with their stations and duties June 30, 1877.

3d. List of officers of the line detailed for staff duty, showing how and where employed at the same date.

In addition to the foregoing, lists of all line officers detached from

their companies or regiments, and performing other than staff duty at the time in question, are also transmitted.

I have the honor to be, sir, very respectfully, your obedient servant,

E. D. TOWNSEND,
Adjutant-General.

The Hon. SECRETARY OF WAR, *Washington, D. C.*

Distribution of United States troops in the several Military Divisions and Departments on the 30th day of June, 1877.

MILITARY DIVISION OF THE ATLANTIC

(Embracing the New England States, State of New York [excepting the Department and the post of West Point], States of New Jersey, Pennsylvania, Delaware, Maryland, Virginia, West Virginia, Ohio, Michigan, Wisconsin, Indiana, and the District of Columbia; also the territory comprehended in the Departments of the Gulf and the South).

Posts.	Number of companies.	Arm of service.	Strength of garrison, present and absent. Commissioned officers.	Enlisted men.	Aggregate.	
Fort Hamilton, N. Y	4	Artillery	20	197	217	Headquarters 3d Art.
Fort Wadsworth, N. Y	2	....do	10	70	80	
Fort Porter, N. Y	1	Infantry	4	33	37	
Fort Niagara, N. Y	1	Artillery	4	37	41	
Fort Ontario, N. Y	1	....do	4	40	44	
Plattsburg Barracks, N. Y	1	....do	4	39	43	
Madison Barracks, N. Y	1	....do	5	39	44	
Fort Wayne, Mich	2	Infantry	9	76	85	Headquarters 22d Inf.
Fort Mackinac, Mich	1	....do	4	29	33	
Fort Schuyler, N. Y	1	Artillery	5	33	38	
Fort Warren, Mass	2	....do	9	65	74	
Fort Independence, Mass	2	....do	10	65	75	
Fort Preble, Me	1	....do	5	38	43	
Fort Trumbull, Conn	2	....do	8	65	73	
Fort Adams, R. I	4	....do	20	198	218	Headquarters 1st Art.
Fort McHenry, Md	3	....do	16	164	180	Headquarters 2d Art.
Fort Foote, Md	1	....do	4	41	45	
Fort Monroe, Va	5	....do	35	263	298	
Washington Arsenal, D. C	6	....do	24	213	237	
Total	41		200	1,705	1,905	

DEPARTMENT OF THE SOUTH

(Embracing the States of North Carolina, South Carolina, Georgia, Florida, and so much of Kentucky and Tennessee as lies east of the Tennessee River).

Posts.	Number of companies.	Arm of service.	Strength of garrison, present and absent. Commissioned officers.	Enlisted men.	Aggregate.	
Fort Johnston, N. C	1	Artillery	4	40	44	
Morganton, N. C	1	Infantry	4	36	40	
Charleston, S. C	3	Artillery	16	162	178	Headquarters 5th Art.
Columbia, S. C	7	Infantry	25	268	293	Headquarters 18th Inf.
Greenville, S. C	2	....do	8	70	78	
Atlanta, Ga	9	....do	32	338	370	Headquarters 2d Inf.
Savannah, Ga	1	Artillery	4	40	44	
Saint Augustine, Fla	2	....do	8	79	87	
Fort Barrancas, Fla	3	....do	10	88	98	
Key West, Fla	2	....do	6	55	61	
Chattanooga, Tenn	1	Infantry	3	38	41	
Total	32		120	1,214	1,334	

DEPARTMENT OF THE GULF

(Embracing the States of Louisiana, Arkansas, Mississippi, Alabama, and the parts of Kentucky and Tennessee lying west of the Tennessee River).

Posts.	Number of companies.	Arm of service.	Strength of garrison, present and absent. Commissioned officers.	Enlisted men.	Aggregate.	
Jackson Barracks, La	3	Infantry	12	128	140	Headquarters 13th Inf.
Baton Rouge, La	3	......do	10	114	124	
Lake Charles, La	2	......do	7	72	79	
Little Rock, Ark	2	......do	7	66	73	
Holly Springs, Miss	1	......do	4	37	41	
Jackson, Miss	1	......do	3	37	40	
Huntsville, Ala	2	......do	7	69	76	
Mobile, Ala	3	......do	14	126	140	Headquarters 3d Inf.
Mount Vernon Barracks, Ala	3	......do	10	90	100	
Total	20		74	739	813	

MILITARY DIVISION OF THE MISSOURI

(Embraces the territory comprehended in the Departments of the Missouri, Dakota, Texas, and the Platte).

DEPARTMENT OF THE MISSOURI

(Embracing the States of Missouri, Kansas, Illinois, and Colorado; Territory of New Mexico, Indian Territory, and the post of Fort Elliott, Tex.).

Posts.	Number of companies.	Arm of service.	Strength of garrison, present and absent. Commissioned officers.	Enlisted men.	Aggregate.	
Fort Dodge, Kans	2	Infantry	7	63	70	
Fort Hays, Kans	1	......do	4	37	41	
Fort Larned, Kans	1	......do	3	33	36	
Fort Leavenworth, Kans	6	......do	22	234	256	Headquarters 23d Inf.
Fort Riley, Kans	3	......do	14	133	147	Headquarters 16th Inf.
Fort Leavenworth Military Prison, Kans.	....	Detachments	6	65	71	
Fort Wallace, Kans	2	Cavalry and infantry	7	105	112	
Fort Elliott, Tex	3	......do	11	113	124	
Fort Gibson, Ind. T	2	Infantry	7	71	78	
Fort Lyon, Colo	1	......do	6	58	64	Headquarters 19th Inf.
Fort Reno, Ind. T	4	Cavalry and infantry	10	215	225	
Fort Sill, Ind. T	8	......do	28	579	607	Headquarters 4th Cav.
Camp Supply, Ind. T	5	......do	15	189	204	
En route changing stations	4	......do	12	166	178	
Fort Marcy, N. Mex	1	Infantry	3	31	34	
Fort Union, N. Mex	5	Cavalry and infantry	16	224	240	
Fort Wingate, N. Mex	3	......do	12	121	133	Headquarters 15th Inf.
Fort Craig, N. Mex	2	Infantry	7	65	72	
Fort Stanton, N. Mex	4	Cavalry and infantry	13	142	155	
Fort Bayard, N. Mex	4	......do	11	131	142	
Fort Garland, Colo	2	......do	7	79	86	
In the field, New Mexico	1	Cavalry	2	36	38	
Total	64		223	2,890	3,113	

DEPARTMENT OF DAKOTA

(Embracing the State of Minnesota and the Territories of Dakota and Montana).

Posts.	Number of companies.	Arm of service.	Strength of garrison, present and absent.			
			Commissioned officers.	Enlisted men.	Aggregate.	
Fort Snelling, Minn	1	Infantry	7	46	53	Headquarters 20th Inf.
Fort Ripley, Minn	1	......do	4	23	27	
Fort Abercrombie, Dak	2	Cavalry and infantry	6	122	128	
Fort Sisseton, Dak	1	Infantry	3	41	44	
Fort Totten, Dak	2	Cavalry and infantry	6	115	121	
Fort Pembina, Dak	2	Infantry	7	66	73	
Fort Seward, Dak	1	......do	3	31	34	
Fort Buford, Dak	7	......do	23	271	294	Headquarters 6th Inf
Fort A. Lincoln, Dak	10	Cavalry and infantry	35	708	743	Headquarters 7th Cav.
Fort Stevenson, Dak	1	Infantry	4	43	47	
Fort Randall, Dak	3	......do	12	126	138	Headquarters 1st Inf
Fort Sully, Dak	4	......do	14	164	178	
Fort Rice, Dak	6	Cavalry and infantry	19	390	409	
Standing Rock Agency, Dak	11	Infantry	35	418	453	Headquarters 17th Inf.
Cheyenne Agency, Dak	9	......do	29	386	415	Headquarters 11th Inf
Fort Shaw, Mont	5	......do	19	199	218	Headquarters 7th Inf
Fort Ellis, Mont	5	Cavalry and infantry	17	394	411	
Fort Benton, Mont	1	Infantry	3	32	35	
Camp Baker, Mont	2	......do	6	62	68	
Missoula, Mont	1	......do	3	38	41	
Camp on Tongue River, Mont	16	......do	48	713	761	Headquarters 5th Inf
Lower Brulé Agency, Dak	1	......do	3	39	42	
Total	92		306	4,427	4,733	

DEPARTMENT OF TEXAS

(Embracing the State of Texas, excepting the post of Fort Elliott, Tex.)

Posts.	Number of companies.	Arm of service.	Strength of garrison, present and absent.			
			Commissioned officers.	Enlisted men.	Aggregate.	
Fort Brown, Tex	7	Cavalry and infantry	25	450	475	Headquarters 8th Cav
Fort Clark, Tex	9	......do	30	556	586	Headquarters 24th Inf
Fort Concho, Tex	6	......do	25	406	431	Headquarters 10th Cav
Fort Davis, Tex	6	......do	20	280	300	Headquarters 25th Inf
Fort Duncan, Tex	3	......do	8	154	162	
Fort Griffin, Tex	1	Cavalry	4	83	87	
Fort McIntosh, Tex	1	Infantry	3	52	55	
Fort McKavett, Tex	6	Cavalry and infantry	20	317	337	Headquarters 10th Inf
Fort Richardson, Tex	1	Cavalry	6	82	88	
Fort Stockton, Tex	4	Cavalry and infantry	11	185	196	
Ringgold Barracks, Tex	7	......do	22	283	305	
San Antonio, Tex	1	Infantry	4	50	54	
San Felipe, Tex	1	Cavalry	4	76	80	
En route changing post	1	......do	3	68	71	
Total	54		185	3,042	3,227	

DEPARTMENT OF THE PLATTE

(Embracing the States of Iowa and Nebraska, Territories of Utah and Wyoming, and so much of the Territory of Idaho as lies east of a line formed by the extension of the western boundary of Utah to the northeastern boundary of Idaho, embracing the post of Fort Hall, Idaho).

Posts.	Number of companies.	Arm of service.	Strength of garrison, present and absent.			
			Commissioned officers.	Enlisted men.	Aggregate.	
Fort Bridger, Wyo	2	Infantry	9	89	98	Headquarters 4th Inf.
Camp Brown, Wyo	1	Cavalry	3	88	91	
Fort Cameron, Utah	1	Infantry	3	39	42	
Cheyenne Depot, Wyo	1	Cavalry	3	63	66	
Camp Douglas, Utah	4	Infantry	15	162	177	Headquarters 14th Inf.
Fort Fetterman, Wyo	3	Cavalry and infantry	10	140	150	
Fort Hall, Idaho	1	Infantry	3	39	42	
Fort Hartsuff, Nebr	1	......do	3	37	40	
Fort McPherson, Nebr	4	Cavalry	12	277	289	
North Platte, Nebr	1	Infantry	3	36	39	
Omaha Barracks, Nebr	8	......do	32	307	339	Headquarters 9th Inf.
Fort D. A. Russell, Wyo	6	Cavalry	24	442	466	Headquarters 5th Cav.
Fort Sanders, Wyo	4	......do	15	323	338	Headquarters 2d Cav.
Sidney Barracks, Nebr	2	......do	6	156	162	
Camp Stambaugh, Wyo	1	......do	3	85	88	
Fort Fred Steele, Wyo	3	Cavalry and infantry	9	182	191	
Fort Laramie, Wyo	6	......do	21	418	439	Headquarters 3d Cav.
Camp Robinson, Nebr	7	......do	22	606	628	
Camp Sheridan, Nebr	2	......do	7	109	116	
Fort McKinney, Wyo	4	Infantry	13	146	159	
Total	62		216	3,744	3,960	

MILITARY DIVISION OF THE PACIFIC

(Embracing the territory comprehended in the departments of California, the Columbia, and Arizona).

DEPARTMENT OF CALIFORNIA

(Embracing the State of Nevada, and so much of California as lies north of a line from the northwest corner of Arizona Territory, to Point Conception, California).

Posts.	Number of companies.	Arm of service.	Strength of garrison, present and absent.			
			Commissioned officers.	Enlisted men.	Aggregate.	
Camp Bidwell, Cal	2	Cavalry and infantry	5	95	100	
Camp McDermit, Nev	1	Cavalry	3	60	63	
Presidio San Francisco, Cal	3	Cavalry and artillery	15	178	193	Headquarters 4th Art.
Camp Halleck, Nev	2	Cavalry and infantry	8	87	95	
San Diego Barracks, Cal	1	Cavalry	3	64	67	
Point San José, Cal	1	Artillery	3	31	34	
Alcatraz Island, Cal	3	Artillery and infantry	8	94	102	
Angel Island, Cal	2	Infantry	9	87	96	Headquarters 12th Inf.
Camp Gaston, Cal	1	......do	3	38	41	
Camp Independence, Cal	1	......do	3	28	31	
Crane's Springs, Nev	1	......do	2	28	30	
Total	18		62	790	852	

DEPARTMENT OF THE COLUMBIA

(Embracing the State of Oregon, and the Territories of Washington, Idaho, and Alaska, excepting so much of Idaho as lies east of a line formed by the extension of the western boundary of Utah, to the northeastern boundary of Idaho, embracing the post of Fort Hall).

Posts.	Number of companies.	Arm of service.	Strength of garrison, present and absent. Commissioned officers.	Enlisted men.	Aggregate.	
Fort Boise, Idaho	1	Infantry	4	32	36	
Fort Lapwai, Idaho	2	Cavalry and infantry	5	65	70	
Fort Canby, Wash	2	Artillery	7	75	82	
Fort Colville, Wash	1	Cavalry	3	50	53	
Fort Townsend, Wash	2	Artillery and infantry	6	59	65	
Fort Vancouver, Wash	3	Infantry	13	115	128	Headquarters 21st Inf.
Fort Walla Walla, Wash	5	Cavalary and infantry	17	273	290	Headquarters 1st Cav.
Fort Klamath, Oreg	2	......do	5	88	93	
Fort Stevens, Oreg	2	Artillery	5	63	68	
Camp Harney, Oreg	2	Cavalry and infantry	7	81	88	
Total	22		72	901	973	

DEPARTMENT OF ARIZONA

(Embracing the Territory of Arizona, and so much of California as lies south of a line from the northwest corner of Arizona to Point Conception, California).

Posts.	Number of companies.	Arm of service.	Strength of garrison, present and absent. Commissioned officers.	Enlisted men.	Aggregate.	
Camp Apache, Ariz	4	Cavalry and infantry	9	240	249	
Camp Bowie, Ariz	2	Cavalry	5	109	114	
Camp Grant, Ariz	4	Cavalry and infantry	17	243	260	Headquarters 6th Cav.
Camp Lowell, Ariz	2	......do	7	139	146	
Camp McDowell, Ariz	2	......do	5	85	90	
Camp Mojave, Ariz	2	Infantry	5	56	61	
Camp Thomas, Ariz	2	Cavalry and infantry	6	132	138	
Camp Verde, Ariz	3	......do	7	157	164	
Fort Whipple, Ariz	2	......do	5	94	99	
Fort Yuma, Cal	2	Infantry	6	53	59	
Total	25		72	1,308	1,380	

DEPARTMENT OF WEST POINT

(Embracing the Military Academy and the post of West Point, New York).

Post.	Number of companies.	Arm of service.	Strength of garrison, present and absent. Commissioned officers.	Enlisted men.	Aggregate.	
West Point, N. Y	1	Engineers and detachments.	56	268	324	

E. D. TOWNSEND,
Adjutant-General.

ADJUTANT-GENERAL'S OFFICE,
Washington, D. C., February 18, 1878.

List of officers of the Adjutant-General's Department, United States Army, showing their stations and duties, June 30, 1877.

Names.	Rank.	Grade.	Stations.	Duties.
E. D. Townsend	Brigadier-general	Adjutant-General	Washington, D. C	In charge of Adjutant-General's Department.
R. C. Drum	Colonel	Assistant adjutant-general	Chicago, Ill	Assistant adjutant-general, headquarters Military Division of the Missouri.
J. B. Fry	do	do	New York City, N. Y	Assistant adjutant-general, headquarters Military Division of the Atlantic.
J. C. Kelton	Lieutenant-colonel	do	San Francisco, Cal	Assistant adjutant-general, headquarters Military Division of the Pacific.
Robert Williams	do	do	Omaha, Nebr	Assistant adjutant-general, headquarters Department of the Platte.
William D. Whipple	do	do	Washington, D. C	Aid-de-camp (with rank of colonel) to the General of the Army, and assistant adjutant-general, headquarters of the Army.
Chauncey McKeever	do	do	Atlanta, Ga	Assistant adjutant-general, headquarters Department of the South.
George D. Ruggles	Major	do	Saint Paul, Minn	Assistant adjutant-general, headquarters Department of Dakota.
T. M. Vincent	do	do	Washington, D. C	On duty in Adjutant-General's Office.
O. D. Greene	do	do	New Orleans, La	Assistant adjutant-general, Department of the Gulf.
Samuel Breck	do	do	San Francisco, Cal	On leave of absence.
Louis H. Pelouze	do	do	Washington, D. C	On duty in Adjutant-General's Office.
H. C. Wood	do	do	Portland, Oreg	Assistant adjutant-general, headquarters Department of the Columbia.
J. H. Taylor	do	do	San Antonio, Tex	Assistant adjutant-general, headquarters Department of Texas.
J. P. Martin	do	do	Prescott, Ariz	Assistant adjutant-general, headquarters Department of Arizona.
E. R. Platt	do	do	Fort Leavenworth, Kans	Assistant adjutant-general, headquarters Department of Missouri.
S. N. Benjamin	do	do	Washington, D. C	On duty in Adjutant-General's Office.

List of officers of the Inspector-General's Department, United States Army, showing their stations and duties, June 30, 1877.

Names.	Rank.	Grade.	Stations.	Duties.
R. B. Marcy	Colonel	Inspector-General	Washington, D. C	In charge of Inspector-General's Department.
D. B. Sacket	do	do	Chicago, Ill	Inspector-general, Military Division of the Missouri.
Edmund Schriver	do	do	San Francisco, Cal	Inspector-general, Military Division of the Pacific.
N. H. Davis	do	do	New York City, N. Y	Inspector-general, Military Division of the Atlantic.
Roger Jones	Lieutenant-colonel	Assistant inspector-general	Washington, D. C	On duty in Inspector-General's Office.
Absalom Baird	do	do	Chicago, Ill	Assistant inspector-general, Military Division of the Missouri.
E. H. Ludington	Major	do	San Francisco, Cal	On sick-leave.

CHIEF SIGNAL-OFFICER, UNITED STATES ARMY.

Col. Albert J. Myer, in charge of the Signal Office, Washington, D. C.

List of officers of the Bureau of Military Justice, United States Army, showing their stations and duties, June 30, 1877.

Names.	Rank.	Grade.	Stations.	Duties.
William McK. Dunn	Brigadier-general	Judge-Advocate General	Washington, D. C	In charge of Bureau of Military Justice.
Guido N. Lieber	Major	Judge-advocate	New York City, N. Y	Judge-advocate, Military Division of the Atlantic.
William Winthrop	...do	...do	Washington, D. C	On duty in office of Judge-Advocate General.
H. Burnham	...do	...do	Omaha, Nebr	Judge-advocate, Department of the Platte.
Thomas F. Barr	...do	...do	Saint Paul, Minn	On leave of absence.
H. P. Curtis	...do	...do	San Francisco, Cal	Judge-advocate, Military Division of the Pacific and Department of California.
Henry Goodfellow	...do	...do	Washington, D. C	On duty in War Department.
David G. Swain	...do	...do	Fort Leavenworth, Kans	Judge-advocate, Department of the Missouri.
Asa B. Gardner	...do	...do	West Point, N. Y	Professor of Law at United States Military Academy.

Addresses and stations of officers of the Quartermaster's Department, 1st of July, 1877.

I.—QUARTERMASTER-GENERAL.

Meigs, Brig. Gen. M. C.

COLONELS AND ASSISTANT QUARTERMASTERS-GENERAL.

Allen, Robert, San Francisco, Cal. Awaiting orders.
Rucker, D. H. In charge of Philadelphia depot of Quartermaster's Department, Philadelphia, Pa.
Ingalls, Rufus, chief quartermaster Military Division of the Pacific and Department of California, San Francisco, Cal.
Easton, L. C., chief quartermaster Military Division of the Atlantic, and in charge of depot, New York City.
Van Vliet, S., Quartermaster-General's Office, Washington, D. C.

LIEUTENANT-COLONELS AND DEPUTY QUARTERMASTERS-GENERAL.

Holabird, S. B., chief quartermaster Military Division of the Missouri, Chicago, Ill.
Tompkins, C. H. Awaiting orders. Address, Box 701, Georgetown, D. C.
Ekin, J. A. In charge of Jeffersonville depot of the Quartermaster's Department, Jeffersonville, Ind., and disbursing agent of Quartermaster's Department at Louisville, Ky.
Eddy, A. R., chief quartermaster Department of the Columbia, Portland, Oreg.
Saxton, Rufus, chief quartermaster Department of the Missouri, Fort Leavenworth, Kans.
Bingham, J. D., Quartermaster-General's Office, Washington, D. C.
Perry, A. J., chief quartermaster Department of Texas, San Antonio, Tex.
Hodges, H. C., Quartermaster-General's Office, Washington, D. C.

MAJORS AND QUARTERMASTERS.

Chandler, J. G., chief quartermaster Department of the South, Atlanta, Ga.
Myers, William. In charge of depot, San Francisco, Cal.
Sawtelle, C. G., post quartermaster, New York City.
Dana, J. J. In charge of clothing depot, Philadelphia, Pa.
Potter, J. A., chief quartermaster Department of the Gulf, New Orleans, La.
Batchelder, R. N. On duty under secret orders.
Ludington, M. I., chief quartermaster Department of the Platte, Omaha, Nebr.
Moore, J. M., Chicago, Ill.
Belger, James, Atlanta, Ga.
Card, B. C., chief quartermaster Department of Dakota, Saint Paul, Minn.
Reynolds, C. A., chief quartermaster Department of Arizona, Prescott, Ariz.
Dandy, G. B., post quartermaster, Buffalo, N. Y.
Weeks, George H. In charge of Vancouver depot, Wash.
Hughes, W. B. In charge of depot, Sioux City, Iowa.

CAPTAINS AND ASSISTANT QUARTERMASTERS.

Robinson, A. G., post quartermaster, Boston, Mass.
Baker, E. D. In charge of depot, San Antonio, Tex. Under orders for duty as post quartermaster at Fort Rice, Dak.
James, H. W., post quartermaster, Baltimore, Md.
Lee, J. G. C., Bismarck, Dak.
Gilliss, James, Cheyenne Depot, Wyo.
Eckerson, T. J. *En route* to join station at Fort Brown, Tex.
McGonnigle, A. J. In charge of depot, New Orleans, La.
Grimes, E. B. In charge of depot, Saint Louis, Mo.
Scully, J. W., Fort Rice, Dak. Under orders for assignment to duty at Charleston, S. C.
Howell, W. T. Awaiting orders. Address, Philadelphia, Pa.
Foster, C. W., Ogden, Utah.
Bradley, G. W., Yuma depot, Ariz.
Barstow, S. F., Charleston, S. C.
Belcher, J. H., chief quartermaster district of New Mexico, Santa Fé, N. Mex.
Kirk, E. B., depot and post quartermaster at Fort Buford, Dak.
Kimball, A. S. In charge of depot, Fort Union, N. Mex.
Rockwell, A. F. In charge of office of National Cemeteries, and depot quartermaster, Washington, D. C.

Smith, G. C., Camp Grant, Ariz.
Strang, E. J., Fort Worth, Tex.
Constable, N. S., Marion, Tex.
Furey, J. V. In charge of depot, Omaha, Neb.
Forsyth, L. C., Fort Adams, R. I.
Hoyt, C. H. In charge of depot Fort Leavenworth, Kans.
Blunt, A. P., governor of military prison Fort Leavenworth, Kans.
Lord, James H., disbursing quartermaster Tucson, Ariz.
Marshall, James M., Fort Ellis, Mont.
Atwood, E. B., Fort Concho, Tex.; under orders for assignment as depot quartermaster at San Antonio, Tex.
Simpson, John, Whipple depot, Prescott, Ariz.
Campbell, L. E., Fort Monroe, Va.
Heintzelman, Charles S., post on Tongue River, Mont. Address, via Bismarck and Fort Buford, Dak.

CAPTAINS AND MILITARY STOREKEEPERS.

Potter, R. M., Fort Wood, New York Harbor. On sick leave. Address, No. 282 Franklin avenue, Brooklyn, N. Y.
Alligood, C. A., Fort Wadsworth, New York Harbor.
Rodgers, J. F., Philadelphia, Pa.
Hull, G. A., Fort Leavenworth, Kans.
Livers, John, Omaha, Nebr.
Barrett, Addison, Jeffersonville, Ind.
Martin, W. P., San Francisco, Cal.

II.—QUARTERMASTER-GENERAL'S OFFICE.

Meigs, Brig. Gen. M. C., Quartermaster-General.
Van Vliet, Col. Stewart, assistant quartermaster-general.
Bingham, Lieut. Col. J. D., deputy quartermaster-general.
Hodges, Lieut. Col. H. C., deputy quartermaster-general.

GENERAL DEPOTS ESTABLISHED BY GENERAL ORDER 32, HEADQUARTERS ARMY, APRIL 8, 1869.

New York.—Easton, Col. L. C., assistant quartermaster-general, in charge.

Philadelphia depot of the Quartermaster's Department.—Rucker, Col. Daniel H., assistant quartermaster-general in charge; Dana, Maj. James J., quartermaster; Rodgers, Capt. John F., military storekeeper.

Washington, D. C.—Rockwell, Capt. A. F., assistant quartermaster, in charge.

Jeffersonville depot of the Quartermaster's Department.—Ekin, Lieut. Col. James A., deputy quartermaster-general, in charge; Barrett, Capt. Addison, military storekeeper.

OFFICE OF NATIONAL CEMETERIES.

Rockwell, Capt. A. F., assistant quartermaster, Washington, D. C., in charge.

MILITARY DIVISION OF THE ATLANTIC.

Headquarters, New York City.—Easton, Col. L. C., assistant quartermaster-general, chief quartermaster; Sawtelle, Maj. C. G., quartermaster, post quartermaster, New York City; Dandy, Maj. G. B., quartermaster, post quartermaster, Buffalo, N. Y.; Robinson, Capt. A. G., assistant quartermaster, post quartermaster, Boston, Mass.; Janes, Capt. Henry W., assistant quartermaster, post quartermaster, Baltimore, Md.; Forsyth, Capt. L. C., assistant quartermaster, post quartermaster, Fort Adams, R. I.; Campbell, Capt. L. E., assistant quartermaster, Fort Monroe, Va.; Potter, Capt. R. M., military storekeeper, Fort Wood, New York Harbor; on sick leave; address No. 282 Franklin avenue, Brooklyn, N. Y.; Alligood, Capt. Charles A., military storekeeper, Fort Wadsworth, New York Harbor.

DEPARTMENT OF THE SOUTH.

Headquarters, Atlanta, Ga.—Chandler, Maj. J. G., quartermaster, chief quartermaster; Belger, Maj. James, quartermaster, Atlanta, Ga.; Barstow, Capt. S. F., assistant quartermaster, Raleigh, N. C.

MILITARY DIVISION OF THE MISSOURI.

Headquarters, Chicago, Ill.—Holabird, Lieut. Col. S. B., deputy quartermaster-general, chief quartermaster; Moore, Maj. J. M., quartermaster, Chicago, Ill.; Hughes, Maj. Wm. B., quartermaster, Sioux City, Iowa; Grimes, Capt. E. B., assistant quartermaster. In charge of depot Saint Louis, Mo.

DEPARTMENT OF THE MISSOURI.

Headquarters, Fort Leavenworth, Kans.—Saxton, Lieut. Col. Rufus, deputy quartermaster general, chief quartermaster; Belcher, Capt. J. H., assistant quartermaster, chief quartermaster District of New Mexico, Santa Fé, N. Mex.; Kimball, Capt. A. S., assistant quartermaster, in charge of depot Fort Union, N. Mex.; Hoyt, Capt. Charles H., assistant quartermaster, in charge of depot, Fort Leavenworth, Kans.; Blunt, Capt. A. P., assistant quartermaster, on duty at military prison, Fort Leavenworth, Kans.; Hull, Capt. Gustavus A., military storekeeper, Fort Leavenworth, Kans.

DEPARTMENT OF THE PLATTE.

Headquarters, Omaha, Nebr.—Ludington, Maj. M. I., quartermaster, chief quartermaster; Gilliss, Capt. James, assistant quartermaster, Cheyenne Depot, Wyo.; Foster, Capt. C. W., assistant quartermaster, Ogden, Utah; Furey, Capt. John V., assistant quartermaster, in charge of depot Omaha, Neb.; Livers, Capt. John, military storekeeper, Omaha, Nebr.

DEPARTMENT OF DAKOTA.

Headquarters, Saint Paul, Minn.—Card, Maj. B. C., quartermaster, chief quartermaster; Lee, Capt. J. G. C., assistant quartermaster, Bismarck, Dak.; Scully, Capt. J. W., assistant quartermaster, Fort Rice, Dak., under orders for assignment to duty at Charleston, S. C.; Kirk, Capt. E. B., assistant quartermaster, depot and post quartermaster, Fort Buford, Dak.; Marshall, Capt. James M., assistant quartermaster, Fort Ellis, Mon.; Heintzelman, Capt. Charles S., assistant quartermaster, post on Tongue River, Mont. Address, via Bismarck and Fort Buford, Dak.

DEPARTMENT OF TEXAS.

Headquarters, San Antonio, Tex.—Perry, Lieut. Col. A. J., deputy quartermaster general, chief quartermaster; Baker, Capt. E. D., assistant quartermaster, in charge of depot San Antonio, Tex., under orders for duty as post quartermaster at Fort Rice, Dak.; Strang, Capt. E. J., assistant quartermaster, Fort Worth, Tex.; Constable, Capt. N. S., assistant quartermaster, Marion, Tex.; Atwood, Capt. E. B., assistant quartermaster, Fort Concho, Tex., under orders for assignment as depot quartermaster at San Antonio, Tex.

DEPARTMENT OF THE GULF.

Headquarters, New Orleans, La.—Potter, Maj. J. A., quartermaster, chief quartermaster; McGonnigle, Capt. A. J., assistant quartermaster, in charge of depot New Orleans, La.

MILITARY DIVISION OF THE PACIFIC AND DEPARTMENT OF CALIFORNIA.

Headquarters, San Francisco, Cal.—Ingalls, Col. Rufus, assistant quartermaster-general, chief quartermaster; Myers, Maj. William, quartermaster, in charge of depot San Francisco, Cal.; Martin, Capt. W. P., military storekeeper, San Francisco, Cal.

DEPARTMENT OF ARIZONA.

Headquarters, Prescott, Ariz.—Reynolds, Maj. C. A., quartermaster, chief quartermaster; Bradley, Capt. G. W., assistant quartermaster, Yuma depot, Ariz.; Smith, Capt. G. C., assistant quartermaster, Camp Grant, Ariz.; Lord, Capt. J. H., assistant quartermaster, Tucson, Ariz.; Simpson, Capt. John, assistant quartermaster, Whipple Depot, Prescott, Ariz.

DEPARTMENT OF THE COLUMBIA.

Headquarters, Portland. Oreg.—Eddy, Lieut. Col. A. R., deputy quartermaster-general, chief quartermaster; Weeks, Maj. George H., quartermaster, Vancouver depot, Wyo.

MISCELLANEOUS.

Allen, Col. Robert, assistant quartermaster-general, San Francisco, Cal., awaiting orders. Tompkins, Lieut. Col. C. H., deputy quartermaster-general, awaiting orders; address box 701, Georgetown, D. C. Batchelder, Maj. R. N., quartermaster, on duty under secret orders. Eckerson, Capt. T. J., assistant quartermaster, en route to join station at Fort Brown, Tex. Howell, Capt. W. T., assistant quartermaster, awaiting orders; address, Philadelphia, Pa.

By order of the Quartermaster-General:

STEWART VAN VLIET,
Assistant Quartermaster-General, U. S. A.

QUARTERMASTER-GENERAL'S OFFICE,
Washington, D. C., July 11, 1877.

List of officers of the Subsistence Department, United States Army, on the 30th day of June, 1877.

Names, rank, &c.	Duty.	Address.
COMMISSARY-GENERAL OF SUBSISTENCE.		
Brigadier-general.		
Robert Macfeely .... Bvt. col., 13 Mar., '65	Commissary-General of Subsistence	Washington, D. C.
ASSISTANT COMMISSARIES-GENERAL OF SUBSISTENCE.		
Colonels.		
Charles L. Kilburn .... Bvt. brig. gen., 13 Mar., '65	Chief C. S., Mil. Div. of the Missouri	Chicago, Ill.
Marcus D. L. Simpson . Bvt. maj. gen., 13 Mar., '65	Chief C. S., Mil. Div. of the Atlantic	New York, N. Y.
Lieutenant-colonels.		
Henry F. Clarke ...... Bvt. maj. gen., 13 Mar., '65	Purchasing and depot C. S. at Baltimore, Md	Baltimore, Md.
William W. Burns .... Bvt. brig. gen., 13 Mar., '65	Chief C. S., Mil. Div. of the Pacific and Dept. of California	San Francisco, Cal.
Amos Beckwith ...... Bvt. maj. gen., 13 Mar., '65	Purchasing and depot C. S. at Saint Louis, Mo	Saint Louis, Mo.
COMMISSARIES OF SUBSISTENCE.		
Majors.		
Beekman DuBarry .... Bvt. col., 13 Mar., '65	Purchasing and depot C. S. at New York, N. Y	New York, N. Y.
Thomas J. Haines .... Bvt. brig. gen., 13 Mar., '65	Assistant to the Commissary-General of Subsistence	Washington, D. C.
George Bell .... Bvt. brig. gen., 9 Apr., '65	Purchasing and depot C. S. at Atlanta, Ga.; chief C. S., Dept. of the South	Atlanta, Ga.
Michael R. Morgan ... Bvt. brig. gen., 9 Apr., '65	Chief C. S., Dept. of Dakota	Saint Paul, Minn.
John P. Hawkins ..... Bvt. maj. gen., 13 Mar., '65	Purchasing and depot C. S. at Omaha, Nebr.; chief C. S., Dept. of the Platte	Omaha, Nebr.
Michael P. Small ..... Bvt. brig. gen., 9 Apr., '65	Purchasing and depot C. S. at Chicago, Ill	Chicago, Ill.
Thomas C. Sullivan ... Bvt. lieut. col., 13 Mar., '65	Purchasing and depot C. S. at New Orleans, La.; chief C. S., Dept. of the Gulf	New Orleans, La.
John W. Barriger .... Bvt. brig. gen., 13 Mar., '65	Assistant to the Commissary-General of Subsistence	Washington, D. C.
Captains.		
Thomas Wilson ...... Bvt. brig. gen., 13 Mar., '65	Purchasing and depot C. S. at Boston, Mass	Boston, Mass.
William H. Bell .... Bvt. maj., 13 Mar., '65	Purchasing and depot C. S. at Portland, Oreg.; chief C. S., Dept. of the Columbia	Portland, Oreg.
Jeremiah H. Gilman ... Bvt. lieut. col., 31 Dec., '65	Purchasing and depot C. S. at Fort Leavenworth, Kans.; chief C. S., Dept. of the Missouri	Fort Leavenworth, Kans.
Samuel T. Cushing .... Bvt. maj., 13 Mar., '65	Purchasing and depot C. S. at San Francisco, Cal	San Francisco, Cal.
William A. Elderkin ...... Bvt. maj., 13 Mar., '65	Purchasing and depot C. S. at Sioux City, Iowa	Sioux City, Iowa.
Charles B. Penrose ... Bvt. lieut. col., 11 Nov., '67	Purchasing and depot C. S. at San Antonio, Tex.; chief C. S., Dept. of Texas	San Antonio, Tex.
William H. Nash .... Bvt. maj., 17 Nov., '65	Depot C. S. at Cheyenne, Wyo	Cheyenne, Wyo.
Charles McClure .... Bvt. maj., 17 Aug., '66	Purchasing and depot C. S. at Saint Paul, Minn	Saint Paul, Minn.
Andrew K. Long ...... Bvt. lieut. col., 2 Mar., '67	Purchasing and depot C. S. at Washington, D. C	Washington, D. C.
Charles P. Eagan	Chief C. S., Dept. of Arizona	Prescott, Ariz.
Fred. F. Whitehead .... Bvt. maj., 2 Mar., '67	Chief C. S., District of New Mexico	Santa Fé, N. Mex.
John F. Weston	Inspecting subsistence department at posts in the Dept. of Dakota	Saint Paul, Minn.

Quarterly report of medical officers, United States Army, with their stations and duties, as reported to the Surgeon-General, July 1, 1877, or at date of last report received at this office.

ALLOWED BY LAW.—One Surgeon-General, one assistant surgeon-general, one chief medical purveyor, four surgeons with the rank of colonel, two assistant medical purveyors, eight surgeons with the rank of lieutenant-colonel, fifty surgeons with the rank of major, one hundred and twenty-five assistant surgeons, and four medical storekeepers.

Surgeon-General.—JOSEPH K. BARNES, Brigadier-general, Washington, D C.
Assistant Surgeon-General.—CHARLES H. CRANE, Colonel, Washington City, D. C.
Chief Medical Purveyor.—JEDEDIAH H. BAXTER, Colonel, Chief Medical Purveyor, United States Army, Washington, D. C.

SURGEONS, ETC.

Name and rank.	Brevet commissions.	Station, July 1, 1877, or at date of last report received at this office.
Colonels.		
Robert Murray	Lieutenant colonel. Colonel.	Awaiting orders, San Francisco, Cal.
Charles Sutherland	Lieutenant-colonel. Colonel.	Acting assistant medical purveyor, New York City, N. Y. Address: Box 108, Station A.
John M. Cuyler	Colonel. Brigadier-general.	Medical director, headquarters Military Division of the Atlantic, Army Building, corner of Houston and Greene streets, New York City, N. Y.
William J. Sloan	Lieutenant-colonel. Colonel. Brigadier-general.	Medical director, headquarters Department of Dakota, Saint Paul, Minn.
Lieutenant-colonels.		
William S. King	Lieutenant-colonel. Colonel.	Attending surgeon and examiner of recruits, Philadelphia, Pa. Address: Corner of Girard and Twelfth streets.
James Simons	Lieutenant-colonel. Colonel.	Attending surgeon and examiner of recruits, Baltimore, Md. Address: 165 Dolphin street.
Charles C. Keeney	Lieutenant-colonel.	Medical director, headquarters Military Division of the Pacific and Department of California, San Francisco, Cal. Address: Post-office box 2033.
John F. Head	Lieutenant colonel.	Medical director, headquarters Department of the South, Atlanta, Ga. (On leave of absence.)
Lewis A. Edwards	Lieutenant-colonel. Colonel.	On sick leave.
John F. Hammond	Lieutenant-colonel.	Attending surgeon, headquarters Military Division of the Atlantic, New York City, N. Y.
Elisha I. Baily	Lieutenant-colonel.	Medical director, headquarters Department of the Columbia, Portland, Oreg.
George E. Cooper	Lieutenant-colonel. Colonel.	Assistant medical purveyor, San Francisco, Cal.
Ebenezer Swift	Lieutenant-colonel. Colonel. Brigadier-general.	Assistant medical purveyor. Now on duty temporarily as medical director, headquarters Department of the Gulf, New Orleans, La.
Glover Perin	Lieutenant-colonel.	Medical director, headquarters Department of the Missouri, Fort Leavenworth, Kans.
Majors.		
John Campbell	Lieutenant-colonel. Colonel.	Post-surgeon, Fort Adams, Newport, R. I., Military Division of the Atlantic.
John E. Summers	....	Medical director, headquarters Department of the Platte, Omaha, Nebr.
Thomas A. McParlin	Lieutenant-colonel. Colonel. Brigadier-general.	Chief medical officer, headquarters District of New Mexico, Santa Fé, N. Mex., and post-surgeon, Fort Marcy, N. Mex., Department of the Missouri.
Joseph B. Brown	Lieutenant-colonel. Colonel. Brigadier-general.	Medical director's office, headquarters Military Division of the Atlantic, New York City. (Temporary duty.)
David L. Magruder	Lieutenant-colonel.	Attending surgeon and examiner of recruits, Saint Louis, Mo. Address: 1600 Lucas Place.
Charles Page	Lieutenant-colonel.	Post-surgeon, Omaha barracks, Nebr., Department of the Platte.
Basil Norris	Lieutenant-colonel. Colonel.	Attending surgeon, Washington City, D. C.
Edward P. Vollum	Lieutenant-colonel.	Post-surgeon, Saint Louis barracks, Saint Louis, Mo.
John Moore	Lieutenant-colonel. Colonel.	Medical director, headquarters Department of Texas, San Antonio, Tex.
Andrew K. Smith	Lieutenant-colonel.	Post-surgeon, Fort Columbus, New York Harbor, N. Y.
R. H. Alexander	Lieutenant-colonel.	Post-surgeon, Fort Vancouver, Wash., Department of the Columbia.
Joseph R. Smith	Lieutenant-colonel. Colonel.	Post surgeon, Fort Monroe, Va., Military Division of the Atlantic.
John F. Randolph	Lieutenant-colonel.	Post-surgeon, Fort Trumbull, New London, Conn., Military Division of the Atlantic.

Surgeons, &c.—Continued

Name and rank.	Brevet commissions.	Station, July 1, 1877, or at date of last report received at this office.
Bernard J. D. Irwin....	Lieutenant-colonel.. Colonel.	Post-surgeon, United States Military Academy, West Point, N. Y.
Anthony Heger........	Lieutenant-colonel..	Post-surgeon, Willets Point, New York Harbor, N. Y.
Charles T. Alexander..	Lieutenant-colonel..	Ordered to accompany the commanding general, Department of the Columbia, during field operations in that department.
Bennett A. Clements...	Lieutenant-colonel..	Post-surgeon, Fort Sanders, Wyo., Department of the Platte.
Joseph C. Baily........	Lieutenant-colonel..	Post-surgeon, Benicia Arsenal, Cal., Department of California.
James C. McKee.......	Lieutenant-colonel..	Medical director, headquarters Department of Arizona, Prescott, Ariz.
Joseph H. Hill........	Major............... Lieutenant-colonel.	Post-surgeon, McPherson barracks, Atlanta, Ga., Department of the South.
Charles H. Alden......	Major .... Lieutenant-colonel.	Post-surgeon, Fort Townsend, Wash., Department of the Columbia.
Warren Webster	Captain.............. Major. Lieutenant-colonel.	Post-surgeon, Fort Warren, Boston Harbor, Mass., Military Division of the Atlantic.
Charles C. Byrne.......	Major............... Lieutenant-colonel.	Post-surgeon, Fort Snelling, Minn., Department of Dakota.
Joseph P. Wright	Captain............. Major. Lieutenant-colonel.	Attending surgeon, military prison, Fort Leavenworth, Kans., Department of the Missouri.
Charles C. Gray........	Captain............. Major. Lieutenant-colonel.	Post-surgeon, Fort Riley, Kans., Department of the Missouri.
William C. Spencer	Captain............. Major. Lieutenant-colonel.	Attending surgeon, headquarters Military Division of the Missouri, Chicago, Ill.
Francis L. Town.......	Captain............. Major. Lieutenant-colonel.	Post-surgeon, Fort Sill, Ind. T., Department of the Missouri.
Dallas Bache..........	Captain............. Major.	Post-surgeon, Angel Island, Cal., Department of California.
Blencowe E. Fryer.....	Captain............. Major.	Post-surgeon, Fort Leavenworth, Kans., Department of the Missouri.
John H. Frantz........	Captain............. Major. Lieutenant-colonel.	Post-surgeon, Fort Preble, Me., Military Division of the Atlantic.
Charles E. Goddard....	Captain............. Major.	Post-surgeon, Fort McKavett, Tex., Department of Texas.
Charles B. White	Captain............. Major.	Post-surgeon, Columbus barracks, Columbus, Ohio.
George M. Sternberg...	Captain............. Major.	Post-surgeon, Fort Walla Walla, Wash., Department of the Columbia. (In the field.)
Joseph J. Woodward...	Captain............. Major. Lieutenant-colonel.	On duty preparing Medical History of the War of the Rebellion, &c., Surgeon-General's Office, Washington City, D. C.
William H. Forwood...	Captain............. Major.	Post-surgeon, Columbia, S. C., Department of the South.
Ely McClellan	Captain............. Major.	Medical director's office, headquarters Department of the South, Atlanta, Ga.
Samuel A. Storrow.....	Captain............. Major.	Post-surgeon, Presidio, San Francisco, Cal., Department of California.
William D. Wolverton	Captain............. Major. Lieutenant-colonel.	Post-surgeon, Fort Abraham Lincoln, Dak., Department of Dakota.
Albert Hartsuff........	Captain............. Major. Lieutenant-colonel.	Post-surgeon, Fort Laramie, Wyo., Department of the Platte.
Charles R. Greenleaf...	Captain............. Major.	Post-surgeon, Thomas barracks, Huntsville, Ala., Department of the Gulf.
J. V. D. Middleton.....	Captain............. Major.	Post-surgeon, Fort Schuyler, New York Harbor, Military Division of the Atlantic. (On leave of absence.)
John H. Janeway......	Captain............. Major. Lieutenant-colonel.	Post-surgeon, Saint Augustine, Fla., Department of the South.
Henry R. Tilton	Captain............. Major.	Post-surgeon, Cantonment at mouth of Tongue River, Mont., Department of Dakota.
Samuel M. Horton.....	Captain............. Major.	Post-surgeon, Fort McHenry, Md., Military Division of the Atlantic.
J. C. G. Happersett....	Captain............. Major.	Post-surgeon, Fort Hamilton, New York Harbor, N. Y., Military Division of the Atlantic.
Alfred A. Woodhull ...	Captain............. Major. Lieutenant-colonel.	Post-surgeon, Camp Halleck, Nev., Department of California. (Temporary duty.)
John S. Billings........	Captain............. Major. Lieutenant-colonel.	Surgeon-General's Office.

Surgeons, &c.—Continued.

Name and rank.	Brevet commissions.	Station, July 1, 1877, or at date of last report received at this office.
William M. Notson	Captain Major.	Post-surgeon, Fort Cameron, Utah, Department of the Platte.
Joseph R. Gibson	Captain Major. Lieutenant-colonel.	Post-surgeon, Fort McPherson, Nebr., Department of the Platte.
D. L. Huntington	Captain Major. Lieutenant-colonel.	Attending surgeon, Old Soldiers' Home, near Washington City, D. C.

ASSISTANT SURGEONS.

Captains.		
George P. Jaquett	Captain Major.	On sick leave from Department of the South. Address Salem, N. J.
William E. Waters	Captain Major.	Fort Columbus, New York Harbor, N. Y. (Temporary duty.)
John W. Williams	Captain Major.	On duty with troops at Washington arsenal, D. C. (Temporary duty.)
Justus M. Brown	Captain Major.	Post-surgeon, Fort Garland, Colo., District of New Mexico, Department of the Missouri.
Charles S. De Graw	Captain Major.	Post-surgeon, Oglethorpe barracks, Savannah, Ga., Department of the South.
V. Buren Hubbard	Captain Major.	Attending surgeon, headquarters Military Division of the Pacific and Department of California, San Francisco, Cal.
John W. Brewer	Captain Major.	Post-surgeon, Fort Bridger, Wyo., Department of the Platte.
John Brooke	Captain Major.	Columbia, S. C, Department of the South.
William H. Gardner	Captain Major.	Post-surgeon, Greenville, S. C., Department of the South.
Harvey E. Brown	Captain Major.	Post-surgeon, Fort Wadsworth, New York Harbor, N. Y. Military Division of the Atlantic.
William E. Whitehead	Captain	Post-surgeon, Fort Larned, Kans., Department of the Missouri.
Charles Smart	Captain	Post-surgeon, Camp Douglas, Utah, Department of the Platte.
Elliott Coues	Captain	On duty with Professor Hayden's Surveying Expedition. Address: 509 Seventh street, N. W., Washington, D. C.
William F. Buchanan	Captain	Post-surgeon, Morganton, N. C., Department of the South.
Henry J. Phillips		On sick leave. Address: Care of medical director, headquarters Military Division of the Atlantic, New York City.
John H. Kinsman	Captain	En route to Department of the Gulf.
P. Middleton	Captain	Post-surgeon, Fort Clark, Tex., Department of Texas.
George A. Otis	Captain Major. Lieutenant-colonel.	On duty preparing the Surgical History of the War of the Rebellion, and curator Army Medical Museum, Surgeon-General's Office, Washington, D. C.
Henry McElderry		Fort Monroe, Va., Military Division of the Atlantic.
William S. Tremaine		Post-surgeon, Fort Dodge, Kans., Department of the Missouri.
Daniel G. Caldwell		Post-surgeon, Fort Griffin, Tex., Department of Texas.
Samuel S. Jessop		Post-surgeon, Charleston, S. C., Department of the South.
Edwin Bentley		Post-surgeon, Little Rock barracks, Little Rock, Ark., Department of the Gulf.
Henry Lippincott		United States Military Academy, West Point, N. Y.
Morse K. Taylor		Attending surgeon, headquarters Department of Texas and post-surgeon, San Antonio, Tex.
John H. Bartholf		Post-surgeon, Camp Harney, Oregon, Department of the Columbia.
Henry M. Cronkhite		Post-surgeon, Camp Verde, Ariz., Department of Arizona.
Egon A. Koerper		Post-surgeon, Camp Sheridan, Nebr., Department of the Platte.
Richard S. Vickery		Fort Schuyler, New York Harbor. (Temporary duty.) Military Division of the Atlantic.
Robert M. O'Reilly		Post-surgeon, Fort Ontario, Oswego, N. Y., Military Division of the Atlantic.
Frank Meacham		Post-surgeon, Fort Brown, Tex., Department of Texas.
Thomas F. Azpell		Fort Lee, Bergen County, N. J. (Not on duty; sick.)
Charles L. Heizmann		Post-surgeon, Fort Niagara, Youngstown, N. Y., Military Division of the Atlantic.
Robert H. White		Post-surgeon, Ringgold barracks, Tex., Department of Texas.
Calvin De Witt		Omaha barracks, Nebr. (Temporary duty.) Department of the Platte.

Assistant surgeons—Continued.

Name and rank.	Brevet commissions.	Station, July 1, 1877, or at date of last report received at this office.
J. Victor De Hanne		En route to Department of Texas.
Carlos Carvallo		Post-surgeon, Fort Union, N. Mex., District of New Mexico, Department of the Missouri.
Alfred C. Girard		Post-surgeon, Fort Randall, Dak., Department of Dakota.
Joseph B. Girard		Post-surgeon, Fort Wayne, Detroit, Mich., Military Division of the Atlantic.
John V. Lauderdale		Post-surgeon, Fort Wingate, N. Mex., District of New Mexico, Department of the Missouri.
Benjamin F. Pope		Post-surgeon, Fort Stockton, Tex., Department of Texas.
James P. Kimball		Post-surgeon, Fort Brady, Mich., Military Division of the Atlantic.
Aug. A. Yeomans		Fort Richardson, Tex., Department of Texas.
Leonard Y. Loring		Post-surgeon, Fort Yuma, Cal., Department of Arizona.
Arch. B. Campbell		Ringgold barracks, Tex., Department of Texas.
William J. Wilson		Post-surgeon, Fort Craig, N. Mex., District of New Mexico, Department of Missouri.
J. A. Fitzgerald		Post-surgeon, Fort Lapwai, Idaho, Department of the Columbia.
Peter Moffatt		Post-surgeon, Fort Mackinac, Mich., Military Division of the Atlantic.
Charles Styer		Post-surgeon, Fort Porter, Buffalo, N. Y., Military Division of the Atlantic.
Joseph H. T. King		Post-surgeon, Fort Concho, Tex., Department of Texas.
Joseph K. Corson		Post-surgeon, Plattsburg barracks, Plattsburg, N. Y., Military Division of the Atlantic.
Daniel Weisel		Post-surgeon, Fort Canby, Wash., Department of the Columbia.
Peter J. A. Cleary		Post surgeon, Fort Lyon, Colo., Department of the Missouri.
Julius H. Patzki		Post surgeon, Fort D. A. Russell, Wyo., Department of the Platte. (On escort duty with the Lieutenant-General.)
Frederick W. Elbrey		McPherson barracks, Atlanta, Ga., Department of the South.
Washington Matthews		Post-surgeon, Camp Independence, Cal., Department of California.
William R. Steinmetz		Post-surgeon, Fort Wallace, Kans., Department of the Missouri.
John D. Hall		Post-surgeon, Fort Independence, Boston Harbor, Mass., Military Division of the Atlantic.
Curtis E. Munn		Post-surgeon, Camp Robinson, Nebr., Department of the Platte.
Ezra Woodruff		Post-surgeon, Fort Davis, Tex., Department of Texas.
Philip F. Harvey		Post-surgeon, Fort Buford, Dak., Department of Dakota.
William H. King		Post-surgeon, Fort Sully, Dak., Department of Dakota.
Stevens G. Cowdrey		Post-surgeon, Mount Vernon barracks, Ala., Department of the Gulf.
John M. Dickson		Post-surgeon, Jackson barracks, New Orleans, La., Department of the Gulf.
Charles B. Byrne		Post-surgeon, Fort Duncan, Tex., Department of Texas.
Frank Reynolds		On sick leave. Address: Care medical director, headquarters Military Division of the Atlantic, New York City.
Clarence Ewen		Post-surgeon, Madison barracks, Sackett's Harbor, N. Y., Military Division of the Atlantic.
First Lieutenants.		
Charles K. Winne	Captain Major. Lieutenant-colonel.	Post-surgeon, Sidney barracks, Nebr., Department of the Platte.
Fred. C. Ainsworth		Post-surgeon, Camp Grant, Ariz., Department of Arizona.
Valery Havard		With troops in the field, Department of Dakota.
John Van R. Hoff		Post-surgeon, Fort Fetterman, Wyo., Department of the Platte.
H. Offley Paulding		Post-surgeon, Fort Ellis, Mont., Department of Dakota.
George W. Adair		Post-surgeon, Fort Richardson, Tex., Department of Texas.
Paul R. Brown		Post-surgeon, Fort Shaw, Mont., Department of Dakota. (In the field with Second Cavalry.)
Edward B. Moseley		Post-surgeon, Mobile barracks, Ala., Department of the Gulf.
Bernard G. Semig		Post-surgeon, San Diego barracks, San Diego, Cal., Department of California. (Ordered to Camp Bidwell, Cal.)
John O. Skinner		Post-surgeon, Fort Johnston, N. C., Department of the South.
James Alex. Finley		Post-surgeon, Fort Elliott, Tex., Department of the Missouri. (Address: Via Camp Supply, Ind. T.)

Assistant surgeons—Continued.

Name and rank.	Brevet commissions.	Station, July 1, 1877, or at date of last report received at this office.
Aug. A. DeLoffre	....	Post-surgeon, Fort Reno, Ind. T., Department of the Missouri.
Timothy E. Wilcox	....	Post-surgeon, Camp Supply, Ind. T., Department of the Missouri.
Louis M. Maus	....	Post-surgeon, Standing Rock agency, Dak., Department of Dakota.
Blair D. Taylor	....	Post-surgeon, Fort Rice, Dak., Department of Dakota.
Curtis E. Price	....	Post-surgeon, Camp Gaston, Cal., Department of California.
J. C. Worthington	....	Post-surgeon, Fort Whipple, Ariz., Department of Arizona.
Henry S. Turrill	....	Fort Davis, Tex., Department of Texas. (On leave of absence.)
Edward T. Comegys	....	Post-surgeon, San Felipe, Tex., Department of Texas.
Walter Reed	....	Post-surgeon, Camp Lowell, Ariz., Department of Arizona.
Henry S. Kilbourne	....	Post-surgeon, Fort Hays, Kans., Department of the Missouri.
James C. Merrill	....	Fort Brown, Tex., Department of Texas.
William R. Hall	....	Ordered to Fort Stevens, Oreg., Department of the Columbia.
Richards Barnett	....	On duty with troops at Lake Charles, Calcasieu Parish, La., Department of the Gulf.
George H. Torney	....	Unassigned, Department of the Missouri.
Louis W. Crampton	....	Post-surgeon, Holly Springs, Miss., Department of the Gulf.
Joseph Y. Porter	....	Post-surgeon, Key West, Fla., Department of the South. (Command temporarily removed to Fort Brooke, Tampa, Fla.)
Marshall W. Wood	....	Cantonment Reno, Wyo., Department of the Platte.
Marcus E. Taylor	....	Post-surgeon, Baton Rouge, La., Department of the Gulf.
William L. Newlands	....	On duty with troops under command of Maj. George B. Sanford, First Cavalry, Department of California.
John B. W. Gardiner	....	Post-surgeon, Camp Apache, Ariz., Department of Arizona.
Robert E. Smith	....	Post-surgeon, Fort Bayard, N. Mex., District of New Mexico, Department of the Missouri.
William C. Shannon	....	Fort Clark, Tex., Department of Texas.
Louis S. Tesson	....	Ordered to new post at mouth of Big Horn River, Mont., Department of Dakota.
William G. Spencer	....	Post-surgeon, Fort Barrancas, Fla., Department of the South. (Command temporarily removed to Camp Barrancas, Powelton, Fla.)
Roland L. Rosson	....	Post-surgeon, Camp Thomas, Ariz., Department of Arizona.
Edwin F. Gardner	....	On duty with troops in the field, Department of Dakota.
William H. Corbusier	....	Post-surgeon, Chattanooga, Tenn., Department of the South,
James W. Buell	....	Fort Concho, Tex., Department of Texas.
Robert W. Shufeldt	....	On duty with Fifth Cavalry at Cantonment Reno, Wyo., Department of the Platte.
Daniel M. Appel	....	Post-surgeon, Fort Stanton, N. Mex., Department of the Missouri.
T. A. Cuningham	....	Post-surgeon, Fort Stevenson, Dak., Department of Dakota.
Harry O. Perley	....	Post-surgeon, Fort Pembina, Dak., Department of Dakota.
Henry G. Burton	....	Post-surgeon, Camp Bowie, Ariz., Department of Arizona.
Samuel Q. Robinson	....	United States Military Academy, West Point, N. Y.
William B. Davis	....	Saint Louis barracks, Saint Louis, Mo.

MEDICAL STOREKEEPERS.

Captains.		
Henry Johnson	....	San Francisco, Cal.
George T. Beall	....	Acting assistant medical purveyor, Saint Louis, Mo.
And. V. Cherbonnier	....	Saint Louis, Mo.
F. O'Donnoghue	....	New York City, N. Y.

RETIRED LIST.

Name and rank.	Brevet commissions.	Residence, July 1, 1877, or at date of last report received at this office.
Surgeon-General.		
Brigadier-General.		
Clement A. Finley	Brigadier-general	West Philadelphia, Pa.
Colonel.		
Joseph J. B. Wright	Colonel Brigadier-general.	Carlisle, Pa.
Lieutenant-Colonels.		
Richard S. Satterlee	Lieutenant-colonel Colonel. Brigadier-general.	New York City. Address: No. 64 West Twentieth street.
Charles McDougall	Colonel Brigadier-general.	Jefferson Barracks, Mo.
Majors.		
Burton Randall	Lieutenant-colonel	Annapolis, Md.
William F. Edgar		Los Angeles, Cal.
Captains.		
Benjamin King		Weston, near West River post-office, Anne Arundel County, Md.
Joseph H. Bailey		Kent Cliffs, Putnam County, N. Y.
Henry R. Silliman	Captain Major.	Philadelphia, Pa. Address: 1639 Park avenue.
Howard Culbertson		Zanesville, Ohio. Address: No. 206 Market street.
William C. Minor	Captain	Unknown.

CHANGES SINCE APRIL 1, 1877.

PROMOTIONS.

Lieut. Col. William J. Sloan, surgeon, to be surgeon, with the rank of colonel, to date April 28, 1877, vice McCormick, deceased.

Maj. Glover Perin, surgeon, to be surgeon, with the rank of lieutenant-colonel, to date April 28, 1877, vice Sloan, promoted.

Capt. D. L. Huntington, assistant-surgeon, to be surgeon, with the rank of major, to date April 28, 1877, vice Perin, promoted.

DIED.

Col. Charles McCormick, surgeon, at New York City, April 28, 1877.

First Lieut. W. C. C. Andrews, assistant surgeon, drowned near Fort Stevens, Oregon, April 19, 1877.

Official:

C. H. CRANE,
Assistant Surgeon-General, U. S. A.

SURGEON-GENERAL'S OFFICE,
Washington, July 10, 1877.

Quarterly station-list of the officers of the Pay Department, United States Army, as by official records in the Paymaster-General's Office, July 1, 1877.

LEGAL ORGANIZATION.—One Paymaster-General, two assistant paymasters-general, two deputy paymasters-general, fifty paymasters.

	Name and rank.	Station.	Remarks.
	PAYMASTER-GENERAL.		
	(*Brigadier-general.*)		
	Benjamin Alvord	Washington, D. C.	
	ASSISTANT PAYMASTERS-GENERAL.		
	(*Colonels.*)		
	Nathan W. Brown	New York City	Chief paymaster, Military Division of the Atlantic.
	Daniel McClure		Relieved from duty. Post-office address: Louisville, Ky.
	DEPUTY PAYMASTERS-GENERAL.		
	(*Lieutenant-colonels.*)		
	Franklin E. Hunt	Leavenworth Kans	Chief paymaster, Department of the Missouri.
	Henry Prince	San Francisco, Cal	Chief paymaster, Division of the Pacific and Department of California.
	PAYMASTERS.		
	(*Majors.*)		
1	Samuel Woods	San Francisco, Cal	
2	George L. Febiger	New York City	
3	Henry C. Pratt	Omaha, Nebr	Chief paymaster, Department of the Platte.
4	Simeon Smith	do	
5	Charles T. Larned	Washington, D. C	In Paymaster-General's Office.
6	Rodney Smith	Prescott, Ariz	Chief paymaster, Department of Arizona.
7	Joseph H. Eaton	Portland, Oreg	Chief paymaster, Department of the Columbia.
8	James B. M. Potter	San Francisco, Cal	
9	William A. Rucker	do	
10	William H. Johnston	Saint Louis, Mo	
11	William R. Gibson	San Antonio, Tex	Chief paymaster, Department of Texas.
12	Charles J. Sprague	Saint Paul, Minn	Chief paymaster, Department of Dakota.
13	William B. Rochester	Atlanta, Ga	Chief paymaster, Department of the South.
14	Henry B. Reese		En route for duty at Saint Paul, Minn.
15	Nicholas Vedder	Atlanta, Ga	
16	Edwin D. Judd	Detroit, Mich	On sick leave. Address: Care H. C. Judd & Root, Hartford, Conn.
17	William Smith	Saint Paul, Minn	
18	Charles M. Terrell	Detroit, Mich	
19	Thad. H. Stanton	Salt Lake City, Utah	
20	George E. Glenn	New Orleans, La	Chief paymaster, Department of the Gulf.
21	Robert D. Clarke	Omaha, Nebr	
22	James H. Nelson	San Francisco, Cal	
23	Charles W. Wingard	Portland, Oreg	Under orders for duty at Washington, D. C.
24	James P. Canby	do	
25	Peter P. G. Hall	New York City	
26	George W. Candee	Sioux City, Iowa	
27	Edmund H. Brooke	Leavenworth. Kans	
28	Israel O. Dewey	Saint Paul, Minn	Under orders for duty at New York City.
29	Asa B. Carey	Washington, D. C	
30	William P. Gould	Charleston, S. C	
31	David Taylor	Leavenworth, Kans	
32	Frank Bridgman	Chicago, Ill	
33	Frank M. Coxe	Fort Brown, Tex	
34	Alfred E. Bates	San Antonio, Tex	
35	John P. Willard	Santa Fé, N. Mex	
36	C. Irving Wilson	San Antonio, Tex	
37	William H. Eckels	New Orleans, La	
38	John E. Blaine	Helena, Mont	
39	James E. Roche	Tucson, Ariz	
40	Albert S. Towar	Santa Fé, N. Mex	
41	Reginald H. Towler	Portland, Oreg	
42	Thomas T. Thornburgh	Omaha, Nebr	
43	William M. Maynadier	Yuma City, Ariz	
44	Josiah A. Brodhead	Leavenworth, Kans	
45	William Arthur	Fort Buford, Dak	
46	James R. Wasson	San Antonio, Tex	
47	Alexander Sharp	Washington, D. C	Post-paymaster.
48	John B. Keefer	Portland, Oreg	
49	Culver C. Sniffen	Washington, D. C	On temporory duty in War Department.
50	Joseph W. Wham	Cheyenne, Wyo	

CASUALTIES SINCE DATE OF LAST STATION-LIST, APRIL 1, 1877.

Name.	Rank.	Date of death.	Place of death.
James R. Mears (retired)	Major	Apr. 26, 1877	Madison, Wis.

RETIRED LIST.

	Name.	Rank.	Date of retirement.	Residence and post-office address.
1	B. W. Brice	Brigadier-general	Jan. 1, 1872	Barnum's Hotel, Baltimore, Md.
2	Hiram Leonard	Lieutenant-colonel	Jan. 1, 1872	San Francisco, Cal.
3	John P. Brua	Major	Feb. 8, 1875	Harrisburg, Pa.
4	Jacob E. Burbank	do	Mar. 3, 1875	Falls City, Nebr.
5	Brantz Mayer	do	June 15, 1875	16 McCulloh street, Baltimore, Md.
6	Valentine C. Hanna	do	Jan. 11, 1877	163 Congress street east, Detroit, Mich.
7	Thomas H. Halsey	do	Feb. 9, 1877	Brandon, Vt.

BENJ'N ALVORD,
Paymaster-General, U. S. A.

Statement showing rank, duties, and address, of officers of the Corps of Engineers and of United States civil engineers, July 1, 1877.

Rank.	Names.	Duties and address.
Brigadier general	Andrew A. Humphreys	Commanding Corps of Engineers; member of commission to examine into canal routes across the isthmus connecting North and South America; member of board for the survey of the harbor of Baltimore City and adjacent waters; member of joint commission to supervise the construction of the Washington Monument; member of advisory board to harbor commissioners, State of Massachusetts; member of board to determine pier and bulkhead lines of New York Harbor along Staten Island shore; member of commission to examine into the matter of contracts between the United States and the Moline Water-Power Company. Office of the Chief of Engineers, Washington, D. C.
Colonel	John G. Barnard	Member of board of engineers for fortifications; member of Light-House Board. Army Building, Houston and Greene streets, New York City.
Colonel	Henry W. Benham	In charge of construction of Forts Winthrop, Independence, and Warren, and w rk on Long Island Head, Mass.; Forts Montgomery, Columbus, Castle Williams, south battery, Governor's Island, Wood, Hamilton, and additional batteries; mortar battery at Fort Hamilton, and fort at Sandy Hook, N. Y. Army Building, Houston and Greene streets, New York City,
Colonel	John N. Macomb	In charge of improvement of the Upper Mississippi and Illinois Rivers, and Des Moines and Rock Island rapids of the Mississippi River; harbors of Fort Madison, Burlington, and Dubuque, Iowa; the survey for the improvement of that portion of the "Mississippi route" designated by the Senate Select Committee on Transportation Routes to Seaboard, as improvements upon a system to be provided so as to give from 4½ to 6 feet depth of water at lowest stages from Falls of Saint Anthony to Alton. Rock Island, Ill.
Colonel	James H. Simpson	In charge of improvement of Mississippi River, between the mouths of the Illinois and Ohio Rivers. 417 Pine street, Saint Louis, Mo.
Colonel	Israel C. Woodruff	On detached service. Engineer third light-house district. Post-office box 4032, New York City.
Colonel	Zelous B. Tower	Member of board of engineers for fortifications. Army Building, Houston and Greene streets, New York City.

Rank, duties, and address of officers of the Corps of Engineers, &c.—Continued.

Rank.	Names.	Duties and address.
Lieutenant-colonel....	Horatio G. Wright	Member of board of engineers for fortifications; member of commission on repavement of Pennsylvania avenue, Washington, D. C.; member of commission to examine into the matter of contracts between the United States and the Moline Water-Power Company. Army Building, Houston and Greene streets, New York City.
Lieutenant-colonel....	John Newton	On leave of absence. Address: Glasgow, Scotland.
Lieutenant-colonel....	George Thom	In charge of works for improvement of rivers Saint Croix, Machias, Penobscot, Kennebec, Kennebunk, Maine, Cocheco, New Hampshire, and Merrimac Massachusetts; of harbors of Camden, Portland, Richmond's Island, Belfast Me., Gloucester, Salem, Boston, Plymouth, and Provincetown, Mass. Portland, Me.
Lieutenant-colonel....	John D. Kurtz	In charge of construction of Forts Delaware, Del., and Mifflin, Pa.; battery at Finn's Point, N. J., and work opposite Fort Delaware; piers at Newcastle and Lewes, Del.; harbor improvements at Wilmington, Del., and on Delaware River and Bay; improvement of the Shrewsbury River and Cohansey Creek, New Jersey, Delaware and Broadkiln Rivers, Delaware and Schuylkill River, Pennsylvania; member of board to examine and report upon the foundation of the Washington Monument. 1328 Chestnut street, Philadelphia, Pa.
Lieutenant-colonel....	Barton S. Alexander	Senior engineer charged with general supervision and inspection of all matters under the command of the Chief of Engineers within the Pacific territory; member of board of engineers for fortifications on the Pacific coast. San Francisco, Cal.
Lieutenant-colonel....	William F. Raynolds...	On detached service. Engineer fourth light-house district. 532 Walnut street, Philadelphia, Pa.
Lieutenant-colonel....	Charles S. Stewart	In charge of construction of fortifications at Fort Point, Point San José, and Angel Island, San Francisco, and at San Diego, Cal.; and improvement of San Diego Harbor and San Joaquin River, California; member of board of engineers for fortifications on the Pacific coast. San Francisco, Cal.
Lieutenant-colonel....	Charles E. Blunt	In charge of improvement of harbors of Rocky River, Cleveland, Grand River, Ashtabula, Conneaut, Erie, Dunkirk, and Buffalo, on Lake Erie; and construction of Fort Porter, N. Y., and of Fort Wayne, Mich. Buffalo, N. Y.
Lieutenant-colonel....	James C. Duane.........	In charge of construction of Forts Gorges, Preble, Scammel, Popham, Knox, and battery at Portland Head, Me., and Forts Constitution and McClary; and batteries on Jerry's Point and Gerrish's Island, Portsmouth Harbor, N. H.; engineer first and second light-house districts; member of board to examine and report upon the foundation of the Washington Monument. Portland, Me.
Lieutenant-colonel....	Robert S. Williamson ...	On detached service. Engineer twelfth light-house district; member board of engineers for fortifications on the Pacific coast. San Francisco, Cal.
Lieutenant-colonel....	Quincy A. Gillmore	In charge of construction of Forts Wadsworth, Tompkins and its batteries, N. Y., Macon and Caswell, N. C., Moultrie, Sumter, Johnson, and Castle Pinckney, S. C., Jackson and Pulaski, Ga., Clinch and Marion, Fla., and temporary charge of Forts Monroe and Wool, Va.; improvement of the bar at the mouth of Saint John's River, and of the inside passage between Saint John's River and Nassau Inlet, Florida, Charleston Harbor, S. C., Savannah River and Harbor; member of board to test the strength and value of all kinds of iron, steel, and other metals submitted to it; member of commission on repavement of Pennsylvania avenue, Washington, D. C.; member of board to examine and report upon the foundation of the Washington Monument. Post-office box 1647, New York City.
Lieutenant-colonel....	Thomas Lincoln Casey..	In charge of the first and second divisions, office of the Chief of Engineers; of public buildings and grounds and certain public works in the District of Columbia; of work upon the building for the State, War, and Navy Departments; and of the Washington Aqueduct; member of board to advise upon the ventilation of the Hall of the House of Representatives. Office of the Chief of Engineers, Washington, D. C.

Rank, duties, and address of officers of the Corps of Engineers, &c.—Continued.

Rank.	Names.	Duties and address.
Major	Nathaniel Michler	In charge of improvement of harbors of Port Clinton, Monroe, Toledo, Sandusky City, Huron, Vermillion, and Black River, on Lake Erie. Toledo, Ohio.
Major	John G. Parke	In charge of the third division. Office of the Chief of Engineers, Washington, D. C.
Major	Gouverneur K. Warren	In charge of construction of defenses of New Bedford Harbor, Mass., Narragansett Bay, Rhode Island; improvement of harbors of Wareham, Hyannis, Fall River, and New Bedford, Mass., Wickford and Newport, R. I.; improvement of rivers Taunton, Massachusetts, Pawtucket and Providence, Rhode Island, Pawcatuck, Rhode Island and Connecticut, and Connecticut. Connecticut, and Little Narragansett Bay, Rhode Island and Connecticut; construction of breakwater at Block Island, R. I.; examining and reporting upon constructing railroad bridges across the Mississippi River between Saint Paul and Saint Louis, &c. Newport, R. I.
Major	George H. Mendell	In charge of construction of fort on Alcatraz Island, and of defenses at Lime Point, San Francisco Bay; breakwater at Wilmington Harbor, Cal.; improvement of Oakland Harbor and Sacramento and Feather Rivers, California; member of board of engineers for fortifications on the Pacific coast; member of advisory board of commissioners on the harbor lines of San Francisco. San Francisco Cal.
Major	Henry L. Abbot	Commanding engineer depot and post of Willets Point and Battalion of Engineers; in charge of construction of Fort Schuyler and fort at Willets Point, N. Y., and of experiments with torpedoes; member of commission to examine into the matter of contracts between the United States and the Moline Water-Power Company. Whitestone, Queens County, N. Y.
Major	William P. Craighill	In charge of construction of defenses of Baltimore, Md., and Washington, D. C.; improvement of Chester, Wicomico, and Elk Rivers, Maryland, James and Appomattox Rivers, Virginia, Great Kanawha and New Rivers, West Virginia, and Cape Fear River, North Carolina, and of the harbor of Baltimore, Md.; member of board for survey of the harbor of Baltimore City and adjacent waters. Union-Bank building, Baltimore, Md.
Major	Cyrus B. Comstock	On leave of absence. Address: Care Baring Bros. & Co., London, England.
Major	Godfrey Weitzel	In charge of improvement of the Falls of the Ohio River, and Louisville and Portland Canal, of Saint Mary's Falls Canal; Saint Mary's, Saint Clair, and Sebawaing Rivers, Michigan; of harbors Au Sable River, Black River, and Thunder Bay; harbor of refuge on Lake Huron, and removal of obstructions from Detroit River; engineer eleventh light-house district. Detroit, Mich.
Major	Orlando M. Poe	On detached service. Aid-de-camp on the personal staff of the General of the Army, with the rank of colonel; member of Light-House Board. Washington, D. C.
Major	David C. Houston	In charge of harbor improvements at Milwaukee, Racine, and Kenosha; improvement of the Fox and Wisconsin Rivers. Milwaukee, Wis.
Major	George H. Elliot	In charge of the fourth and fifth divisions. Office of the Chief of Engineers, Washington, D. C.
Major	Henry M. Robert	In charge of harbor improvements at Ontonagon, Eagle Harbor, Marquette, Menomonee, Green Bay, Ahnepee, Two Rivers, Manitowoc, Sheboygan, Port Washington, and harbor of refuge at entrance of Sturgeon Bay Canal. Milwaukee, Wis.
Major	William E. Merrill	In charge of improvement of the Ohio and Monongahela Rivers, and the Little Kanawha River, West Virginia; engineer fourteenth light-house district, 82 West Third street, Cincinnati, Ohio.
Major	Walter McFarland	In charge of construction of Forts Ontario and Niagara, N. Y.; of harbor improvements at Olcott, Oak Orchard, Charlotte, Pultneyville, Big Sodus, Little Sodus, Oswego, Ogdensburg, and Wilson, N. Y.; engineer tenth light-house district. Oswego, N. Y.
Major	Orville E. Babcock	On detached service. Engineer fifth light-house district. 1 Courtland street, Baltimore, Md.

Rank, duties, and address of officers of the Corps of Engineers, &c.—Continued.

Rank.	Name.	Duties and address.
Major	John M. Wilson	In charge of works for defense of the mouth of the Columbia River, and improvement of the Willamette, Columbia and Snake Rivers; construction of canal around the Cascades of the Columbia River. Engineer thirteenth light house district. Portland, Oreg.
Major	Franklin Harwood	In charge of Saint Clair Flats Canal and improvement of Saginaw River and Cheboygan Harbor, Michigan. Room 57 Moffat block, Detroit, Mich.
Major	John W. Barlow	In charge of Forts Griswold and Hale and the construction of Fort Trumbull, Conn.; improvement of harbors of Stonington, New Haven, Bridgeport, Milford, Southport, and Norwalk, Conn., and Port Jefferson, N. Y.; improvement of Housatonic River, Connecticut. New London, Conn.
Major	Peter C. Hains	On detached service. Engineer secretary of Light-House Board. Treasury Department, Washington, D. C.
Major	Francis U. Farquhar	In charge of harbor improvements at Superior City, Superior Bay, and Duluth; improvement of the Falls of Saint Anthony and of the Mississippi River above the Falls of Saint Anthony; improvement of Chippewa and Minnesota Rivers and the Red River of the North; construction of Meeker's Island lock and dam. Saint Paul, Minn.
Major	George L. Gillespie	On leave of absence. Address: Care N. M. Rothschild & Son, London, England.
Major	Charles R. Suter	In charge of improvement of the Mississippi, Missouri, Arkansas, White, and Saint Francis Rivers. Engineer fifteenth light-house district. 216 North Eighth street, Saint Louis, Mo.
Major	Jared A. Smith	In charge of the improvement of the Wabash River. Indianapolis, Ind.
Major	Samuel M. Mansfield	In charge of harbor improvements at Charlevoix, Frankfort, Manistee, Ludington, Pent Water, White River, Muskegon, Grand Haven, Black Lake, Saugatuck, South Haven, and Saint Joseph, on Lake Michigan. Detroit, Mich.
Captain	William J. Twining	On temporary duty in Office of the Chief of Engineers. Office of the Chief of Engineers, Washington, D. C.
Captain	William R. King	In charge of improvement of the Tennessee River; Cumberland River above and below Nashville, Tenn., and Hiawassee River, Tennessee, Oostenaula, Coosawattee, Etowah, and Ocmulgee Rivers, Georgia, and Coosa Rivers, Georgia and Alabama. Chattanooga, Tenn.
Captain	Wm. H. H. Benyaurd	In charge of improvement of the Ouachita River in Louisiana and Arkansas, and of the Yazoo River in Mississippi, and Cypress Bayou, Texas; of water-gauges on the Mississippi River and its principal tributaries; removal of raft in Red River, Louisiana; dredging at foot of Sodo Lake, Texas. Memphis, Tenn.
Captain	Charles W. Howell	In charge of construction of Forts Pike, Macomb, Tower Duprés, Battery Bienvenue, tower at Proctorsville, Jackson, Saint Philip, and Livingston; improvement of the mouth of the Mississippi River at Southwest Pass, Galveston Harbor, Sabine Pass, and Red Fish Bar in Galveston Bay; improvement and survey of ship-channel San Jacinto River to Bolivar Channel, Galveston Bay, Texas; improvement of Paso Cavallo, Texas. Drawer 432, New Orleans, La.
Captain	Garret J. Lydecker	Engineer officer, Military Division of the Missouri. In charge of the construction of the harbors of Chicago, Calumet, Michigan City, and New Buffalo. Chicago, Ill.
Captain	Arthur H. Burnham	On duty under immediate orders of Colonel Benham. Box 209, Boston, Mass.
Captain	Amos Stickney	On duty under immediate orders of Colonel Macomb. Keokuk, Iowa.
Captain	James W. Cuyler	On duty under immediate orders of Major Craighill. Wilmington, N. C.
Captain	Alexander Mackenzie	On duty under immediate orders of Major Weitzel. Louisville, Ky.
Captain	Oswald H. Ernst	Commanding Company E, Battalion of Engineers. On duty at the Military Academy as instructor of practical military engineering, military signaling, and telegraphy. West Point, N. Y.
Captain	David P. Heap	On duty under immediate orders of Major Warren. Newport, R. I.
Captain	William Ludlow	On duty under immediate orders of Lieutenant-Colonel Kurtz. Lewes, Del.

Rank, duties, and address of officers of the Corps of Engineers, &c.—Continued.

Rank.	Name.	Duties and address.
Captain	Charles B. Phillips	On duty under immediate orders of Major Craighill. Member of advisory board to State harbor commission of Norfolk and Portsmouth. Union Bank building, Baltimore, Md.
Captain	William A. Jones	On detached service. Engineer sixth light-house district. Charleston, S. C.
Captain	Andrew N. Damrell	In charge of construction of defenses of Mobile and Pensacola, and fort on Ship Island, Mississippi; improvement of harbor of Mobile; of Chattahoochie and Flint Rivers, Georgia; Apalachicola River, Florida; and Warrior and Tombigbee Rivers, Alabama; removal of obstructions in the Choctawhatchie River, Alabama and Florida; dredging the bar at mouth of harbor at Cedar Keys, Fla. Engineer eighth light-house district. Mobile, Ala.
Captain	Charles J. Allen	On duty under immediate orders of Colonel Simpson. 417 Pine street, Saint Louis, Mo.
Captain	Charles W. Raymond	On detached service. On duty at the Military Academy. West Point, N. Y.
Captain	Lewis C. Overman	On duty under immediate orders of Captain King. Nashville, Tenn.
Captain	Alexander M. Miller	Commanding Company B, Battalion of Engineers. Whitestone, Queens County, N. Y.
Captain	Micah R. Brown	Detailed to report upon the depth and width of a channel secured and maintained by jetties, constructed by James B. Eads, at the mouth of the Mississippi River. Port Eads, La.
Captain	Milton B. Adams	On duty under immediate orders of Lieutenant-Colonel Blunt. Cleveland, Ohio.
Captain	William R. Livermore	Commanding Company C, Battalion of Engineers. Whitestone, Queens County, N. Y.
Captain	William H. Heuer	In charge of construction of Forts Jefferson and Taylor, Fla. Engineer seventh light-house district. Key West, Fla.
Captain	William S Stanton	On detached service. Engineer officer, Department of the Platte. Post-office box 544, Omaha, Nebr.
Captain	A. Nisbet Lee	On duty under immediate orders of Major Weitzel. Detroit, Mich.
Captain	Thomas H. Handbury	Commanding Company A. Battalion of Engineers. Whitestone, Queens County, N. Y.
Captain	James C. Post	On duty under immediate orders of Lieutenant-Colonel Gillmore. Post-office box 266, Savannah, Ga.
Captain	James F. Gregory	On detached service. Engineer officer, Department of Texas. San Antonia, Tex.
Captain	Henry M. Adams	In charge of the survey of the northern and northwestern lakes and survey of the Mississippi River. Detroit, Mich.
Captain	James Mercur	In temporary charge of manufacture and supply of mastic; improvement of the Hudson River, Harlem River, and East Chester Creek, New York; Otter Creek, Vermont; and Passaic River, New Jersey; removal of obstructions in the East River, including Hell Gate, New York; improvement of channel between Staten Island and New Jersey; harbor improvements at Burlington and Swanton, Vt.; Rondout, Port Chester, and Plattsburg, N. Y.; the survey of so much of the third subdivision of the "northern route" designated by the Senate Select Committee on Transportation-Routes to the Seaboard as extends from Troy, on the Hudson River, to New York City. Army building, Houston and Greene streets, New York City.
First Lieutenant	Charles E. L. B. Davis	On duty under immediate orders of Captain Howell. Post-office box 900, Galveston, Tex.
First Lieutenant	Benjamin D. Greene	Adjutant Battalion of Engineers and post of Willets Point; post treasurer and signal-officer. Whitestone, Queens County, N. Y.
First Lieutenant	George M. Wheeler	In charge of geographical surveys of the territory west of the one hundredth meridian. Post-office lock-box 93, Washington, D. C.
First Lieutenant	James B. Quinn	Quartermaster Battalion of Engineers; acting assistant quartermaster and acting commissary of subsistence and recruiting-officer post of Willets Point. Whitestone, Queens County, N. Y.
First Lieutenant	Daniel W. Lockwood	On duty under immediate orders of Capt. H. M. Adams. Detroit, Mich.
First Lieutenant	Ernest H. Ruffner	On detached service. Engineer officer, Department of the Missouri. Fort Leavenworth, Kans.
First Lieutenant	John C. Mallery	On detached service. Engineer officer, Military Division of the Pacific. San Francisco, Cal.
First Lieutenant	Clinton B. Sears	On detached service. On duty at the Military Academy. West Point, N. Y.
First Lieutenant	Thomas Turtle	On duty under immediate orders of Major Craighill. Kanawha Court-House, W. Va.

Rank, duties, and address of officers of the Corps of Engineers, &c.—Continued.

Rank.	Name.	Duties and address.
First Lieutenant	Edward Maguire	On detached service. Engineer officer, Department of Dakota. In charge of the improvement of the Missouri River above the mouth of the Yellowstone, under the direction of the Chief of Engineers. Saint Paul, Minn.
First Lieutenant	Frederick A. Mahan	On duty under immediate orders of Major Merrill. 82 West Third street, Cincinnati, Ohio.
First Lieutenant	Charles F. Powell	On duty under immediate orders of Capt. H. M. Adams. Detroit, Mich.
First Lieutenant	Frederick A. Hinman	On duty under immediate orders of Major Houston. 433 Broadway, Milwaukee, Wis.
First Lieutenant	Albert H. Payson	On duty under immediate orders of Lieutenant-Colonel Stewart and of the board of engineers for fortifications on the Pacific coast. San Francisco, Cal.
First Lieutenant	John G. D. Knight	On detached service. On duty at the Military Academy. West Point, N. Y.
First Lieutenant	Richard L. Hoxie	On detached service. Chief engineer of the District of Columbia, under the direction of the Board of Commissioners. Columbia building, Fourth-and-a half street, Washington, D. C.
First Lieutenant	Edgar W. Bass	On detached service. On duty at the Military Academy, West Point, N. Y.
First Lieutenant	William L. Marshall	On duty under immediate orders of Captain King. Rome, Ga.
First Lieutenant	Joseph H. Willard	On duty under immediate orders of Captain Mercur. Post-office box 228, Albany, N. Y.
First Lieutenant	Eric Bergland	On duty under immediate orders of Lieutenant Wheeler. Post-office lock-box 93, Washington, D. C.
First Lieutenant	Samuel E. Tillman	On duty under immediate orders of Lieutenant Wheeler. Post-office lock-box 93, Washington, D. C.
First Lieutenant	Philip M. Price	On duty under immediate orders of Capt. H. M. Adams. Detroit, Mich.
First Lieutenant	Francis V. Greene	On detached service. On duty under the Department of State as military attaché of the United States legation at St. Petersburg. United States legation, St. Petersburg, Russia.
First Lieutenant	Carl F. Palfrey	On detached service. On duty at the Military Academy. West Point, N. Y.
First Lieutenant	William H. Bixby	On detached service. On duty at the Military Academy. West Point, N. Y.
First Lieutenant	Henry S. Taber	On duty at the Military Academy and with Company E, Battalion of Engineers. West Point, N. Y.
Second Lieutenant	William T. Rossell	On detached service. On duty at the Military Academy. West Point, N. Y.
Second Lieutenant	Thomas N. Bailey	On detached service. On duty at the Military Academy. West Point, N. Y.
Second Lieutenant	Thomas W. Symons	On duty under immediate orders of Lieutenant Wheeler. Post-office lock-box 93, Washington, D. C.
Second Lieutenant	Smith S. Leach	On duty with Company C, Battalion of Engineers. Whitestone, Queens County, N. Y.
Second Lieutenant	Dan C. Kingman	On duty with Company C, Battalion of Engineers. Whitestone, Queens County, N. Y.
Second Lieutenant	Eugene Griffin	On duty with Company B, Battalion of Engineers. Whitestone, Queens County, N. Y.
Second Lieutenant	Willard Young	On duty with Company A, Battalion of Engineers. Whitestone, Queens County, N. Y.
Second Lieutenant	William M. Black	On graduating leave.
Second Lieutenant	Walter L. Fisk	On graduating leave.
Second Lieutenant	Solomon W. Roessler	On graduating leave.
RETIRED.		
Colonel	Henry Brewerton	Newburg, N. Y.
Colonel	Thomas J. Cram	1817 De Lancy Place, Philadelphia, Pa.
Colonel	George W. Cullum	315 Fifth avenue, New York City.
Lieutenant-colonel	Lorenzo Sitgreaves	1226 F street, Washington, D. C.
Major	Frederick E. Prime	Care of Dr. Buell, Litchfield, Conn.
UNITED STATES CIVIL ENGINEERS.		
	Clarence King	In charge of geological exploration of fortieth parallel. 23 Fifth avenue, New York City.
	S. T. Abert	In charge of improvement of Occoquan, Rappahannock, Elizabeth, and Nansemond Rivers, Virginia; Roanoke, Pamlico, Perquimons, and French Broad Rivers, North Carolina; of Aquia, Accotink, and Nomini Creeks, Virginia; of the harbors of Washington and Georgetown, D. C.; and Norfolk, Va. Corner Nineteenth street and Pennsylvania avenue, Washington, D. C.

By command of Brigadier-General Humphreys,

THOMAS LINCOLN CASEY,
Lieutenant-Colonel of Engineers.

[ORDNANCE ORDERS NO. 31.]

ORDNANCE OFFICE, WAR DEPARTMENT,
Washington, July 1, 1877.

With the view of enabling the officers of the Ordnance Department to know the exact address of every officer of the department, the following list, giving the names, duties to which assigned, and address of each of them, so far as known on the 1st day of July, 1877, has been prepared, and is herewith transmitted for their information.

S. V. BENÉT,
Brigadier-General, Chief of Ordnance.

Stations and duties of the officers of the Ordnance Department on the 1st *day of July*, 1877.

Name and rank.	Duty.	Address.
BRIGADIER-GENERAL.		
Stephen V. Benét	Chief of Ordnance	Washington, D. C.
COLONELS.		
1. P. V. Hagner, bvt. brig. gen.	Commanding Watervliet arsenal	West Troy, N. Y.
2. F. D. Callender, bvt. brig. gen.	Commanding Augusta arsenal	Augusta, Ga.
3. T. T. S. Laidley, brevet	Commanding Watertown arsenal, and president of the United States board to test iron, steel, &c.	Watertown, Mass.
LIEUTENANT-COLONELS.		
1. J. G. Benton, brevet colonel	Commanding National Armory	Springfield, Mass.
2. J. McNutt, brevet colonel	Commanding Washington arsenal	Washington, D. C.
3. J. McAllister, brevet colonel	Commanding Benicia arsenal	Benicia, Cal.
4. S. Crispin, brevet colonel	Commanding New York agency; chief ordnance officer, Division of the Atlantic; president of the ordnance board and constructor of ordnance.	Corner of Houston and Greene streets, N. Y. Post-office box 1811.
MAJORS.		
1. J. W. Todd	Commanding Saint Louis arsenal	Saint Louis arsenal, Mo.
2. T. J. Treadwell, bvt. lt. col.	Member of the ordnance board	Corner of Houston and Greene streets, N. Y. Post-office box 1811.
3. T. G. Baylor, brevet colonel	Commanding New York arsenal, and member of the ordnance board.	Governor's Island, New York Harbor. Post-office box 1449.
4. J. M. Whittemore, brevet	Commanding Frankford arsenal	Philadelphia, Pa.
5. A. R. Buffington, brevet	Commanding Allegheny arsenal	Pittsburgh, Pa.
6. D. W. Flagler, bvt. lieut. col.	Commanding Rock Island arsenal	Rock Island, Ill.
7. A. Mordecai, bvt. lieut. col.	Instructor of ordnance and gunnery, Military Academy.	West Point, N. Y.
8. S. C. Lyford, bvt. lieut. col.	On duty in the office of the Chief of Ordnance, and chairman of executive departments board, International Exhibition, 1876.	Washington, D. C.
9. F. H. Parker, brevet	Commanding Fort Monroe arsenal	Old Point Comfort, Va.
10. J. P. Farley	Commanding Kennebec arsenal	Augusta, Me.
CAPTAINS.		
1. L. S. Babbitt, brevet	Chief ordnance officer, Department of the Columbia.	Portland, Oreg.
2. W. A. Marye, brevet	Assistant, Benicia arsenal	Benicia, Cal.
3. I. Arnold, jr., brevet	Commanding Indianapolis arsenal	Indianapolis, Ind.
4. J. H. Rollins, brevet	Assistant, Watervliet arsenal	West Troy, N. Y.
5. C. Comly, brevet	Commanding San Antonio arsenal, and chief ordnance officer, Department of Texas.	San Antonio, Tex.
6. J. R. McGinness, brevet major	Chief ordnance officer, Department of the South.	Atlanta, Ga.
7. G. W. McKee, brevet major	Assistant, National Armory	Springfield, Mass.
8. F. H. Phipps, brevet	Recorder of the ordnance board	Corner of Houston and Greene streets, N. Y. Post-office box 1811.
9. J. W. Reilly, brevet	Chief ordnance officer, Division of the Missouri.	Chicago, Ill.
10. G. D. Ramsay, jr., brevet	Assistant, Indianapolis arsenal	Indianapolis, Ind.
11. J. A. Kress, brevet major	Commanding Vancouver arsenal	Vancouver, Wash. Ter.
12. O. E. Michaelis, brevet	Chief ordnance officer, Department of Dakota.	Saint Paul, Minn.
13. W. Prince, brevet	Chief ordnance officer, Department of the Gulf.	New Orleans, La.
14. C. E. Dutton	Chief ordnance officer, Department of the Platte, on temporary duty with Powell's geological survey of the Rocky Mountain region.	Omaha, Nebr.

Stations and duties of the officers of the Ordnance Department, &c.—Continued.

Name and rank.	Duty.	Address.
CAPTAINS—Continued.		
15. J. G. Butler	Assistant, Watervliet arsenal	West Troy, N. Y.
16. C. Bryant	Assistant to constructor of ordnance	South Boston Foundery, Boston, Mass.
17. M. L. Poland, brevet	Assistant, Benicia arsenal	Benicia, Cal.
18. A. L. Varney	Chief ordnance officer, Department of the Missouri.	Fort Leavenworth, Kans.
19. J. C. Clifford	Assistant, Rock Island arsenal	Rock Island, Ill.
20. E. M. Wright	Assistant, Frankford arsenal	Philadelphia, Pa.
FIRST LIEUTENANTS.		
1. J. E. Greer	Assistant, National Armory	Springfield, Mass.
2. J. Pitman	Assistant, Watertown arsenal	Watertown, Mass.
3. C. Shaler, jr	Assistant instructor of ordnance and gunnery, Military Academy.	West Point, N. Y.
4. H. Metcalfe	Assistant, Frankford arsenal	Philadelphia, Pa.
5. W. S. Starring	Assistant to constructor of ordnance	Corner of Houston and Greene streets, N. Y. Post office box 1811.
6. C. S. Smith	Assistant, New York agency	Do.
7. S. E. Blunt	Acting assistant professor of mathematics, Military Academy.	West Point, N. Y.
8. F. Heath	Assistant, Frankford arsenal	Philadelphia, Pa.
9. D. M. Taylor	Assistant, Rock Island arsenal	Rock Island, Ill.
10. D. A. Lyle	Assistant, National Armory, and on special duty experimenting with life-saving apparatus, &c.	Springfield, Mass.
11. J. Rockwell, jr	Assistant, Rock Island arsenal	Rock Island, Ill.
12. W. B. Weir	Assistant, Watervliet arsenal.	West Troy, N. Y.
13. J. C. Ayres	On temporary duty as chief ordnance officer, Department of the Platte.	Omaha, Nebr.
14. M. W. Lyon	Assistant, Allegheny arsenal	Pittsburgh, Pa.
15. C. W. Whipple	Assistant to constructor of ordnance	Cold Spring, N. Y.
16. A. H. Russell	Acting assistant professor of philosophy, Military Academy.	West Point, N. Y.
ORDNANCE STOREKEEPERS. (*Not in the line of promotion.*)		
E. Ingersoll, major	On duty, National Armory	Springfield, Mass.
W. R. Shoemaker, captain	In charge Fort Union arsenal	Fort Union, N. Mex.
B. H. Gilbreth, captain	On duty, Watertown arsenal	Watertown, Mass.
E. D. Ellsworth, captain	On sick leave	Mechanicsville, N. Y.
W. Adams, captain	On duty, Fort Monroe arsenal	Old Point Comfort, Va.
A. S. M. Morgan, captain	On duty, Rock Island arsenal	Rock Island, Ill.
W. H. Rexford, captain	On duty, Benicia arsenal	Benicia, Cal.
F. Whyte, captain	On duty, Washington arsenal	Washington, D. C.
D. J. Young, captain	On duty, Watervliet arsenal	West Troy, N. Y.
M. J. Grealish, captain	On duty, Augusta arsenal	Augusta, Ga.

RETIRED OFFICERS.

Brig. Gen. G. D. Ramsay, brevet major-general	Washington, D. C.
Col. R. H. K. Whiteley, brevet brigadier-general	Baltimore, Md.
Lieut. Col. C. P. Kingsbury, brevet brigadier-general	Brooklyn, N. Y.
Capt. J. C. Symmes	Homburg von der Höhe, Germany.

Capt. T. M. Deane, O. S. K., died January 21, 1877.

List of ordnance stations and officers on duty thereat.

	Ordnance stations.	State.	Officers on duty.
	Ordnance office	Dist. Columbia	Brig. Gen. S. V. Benét, Maj. S. C. Lyford.
1	Allegheny arsenal	Pennsylvania	Maj. A. R. Buffington, First Lieut. M. W. Lyon.
2	Augusta arsenal	Georgia	Col. F. D. Callender, Capt. M. J. Grealish, ordnance storekeeper.
3	Benicia arsenal	California	Lieut. Col. J. McAllister, Capt. W. A. Marye, Capt. M. L. Poland, Capt. W. H. Rexford, ordnance storekeeper.
4	Fort Monroe arsenal	Virginia	Maj. F. H. Parker, Capt. W. Adams, ordnance storekeeper.
5	Fort Union arsenal	New Mexico	Capt. W. R. Shoemaker, ordnance storekeeper.
6	Frankford arsenal	Pennsylvania	Maj. J. M. Whittemore, Capt. E. M. Wright, First Lieut. H. Metcalfe, First Lieut. F. Heath.
7	Indianapolis arsenal	Indiana	Capt. I. Arnold, jr., Capt. G. D. Ramsay, jr.
8	Kennebec arsenal	Maine	Maj. J. P. Farley.
9	National Armory	Massachusetts	Lieut. Col. J. G. Benton, Capt. George W. McKee, First Lieut. J. E. Greer, First Lieut. D. A. Lyle, Maj. E. Ingersoll, ordnance storekeeper.
10	Pikesville arsenal	Maryland	In charge of a sergeant of ordnance.
11	Rock Island arsenal	Illinois	Maj. D. W. Flagler, Capt. J. C. Clifford, First Lieut. D. M. Taylor, First Lieut. J. Rockwell, jr., Capt. A. S. M. Morgan, ordnance storekeeper.
12	Saint Louis arsenal	Missouri	Maj. J. W. Todd.
13	San Antonio arsenal	Texas	Capt. C. Comly.
14	Vancouver arsenal	Washington Ter.	Capt. J. A. Kress.
15	Washington arsenal	Dist. Columbia	Lieut. Col. J. McNutt, Capt. F. Whyte, ordnance storekeeper.
16	Watertown arsenal	Massachusetts	Col. T. T. S. Laidley, First Lieut. J. Pitman, Capt. B. H. Gilbreth, ordnance storekeeper.
17	Watervliet arsenal	New York	Col. P. V. Hagner, Capt. J. H. Rollins, Capt. J. G. Butler, First Lieut. W. B. Weir, Capt. D. J. Young, ordnance storekeeper.
18	New York agency	....do	Lieut. Col. S. Crispin, First Lieut. C. S. Smith.
19	New York arsenal	....do	Maj. T. G. Baylor.
20	United States Military Academy.	....do	Maj. A. Mordecai, First Lieut. C. Shaler, jr., First Lieut. S. E. Blunt, First Lieut. A. H. Russell.
21	The ordnance board		Lieut. Col. S. Crispin, Maj. T. J. Treadwell, Maj. T. G. Baylor, Capt. F. H. Phipps.
22	Military department and division headquarters.		Lieut. Col. S. Crispin, Capt. L. S. Babbitt, Capt. C. Comly, Capt. J. R. McGinness, Capt. J. W. Reilly, Capt. O. E. Michaelis, Capt. William Prince, Capt. C. E. Dutton, Capt. A. L. Varney, First Lieut. J. C. Ayres.
23	Special ordnance service		Capt. C. Bryant, First Lieut. W. S. Starring, First Lieut. D. A. Lyle, First Lieut. C. W. Whipple.

E. D. TOWNSEND,
Adjutant-General.

ADJUTANT GENERAL'S OFFICE,
Washington, D. C., February 18, 1878.

List of line officers of the United States Army performing staff duties June 30, 1877.

Name.	Rank and regiment.	Station.	Duty.
A. McD. McCook	Lt. col. 10th Inf.	Washington, D. C.	Aid-de-camp to General Sherman.
J. C. Audenried	Capt. 6th Cav	do	Do.
J. E. Tourtellotte	Capt. 7th Cav	do	Do.
J. M. Bacon	Capt. 9th Cav	do	Do.
J. W. Forsyth	Maj. 10th Cav	Chicago, Ill	Military secretary to Lieutenant-General Sheridan.
G. A. Forsyth	Maj. 9th Cav	do	Acting aid-de-camp to Lieutenant-General Sheridan.
M. V. Sheridan	Capt. 7th Cav	do	Aid-de-camp to Lieutenant-General Sheridan.
F. D. Grant	1st lt. 4th Cav	do	Do.
W. G. Mitchell	Capt. 5th Inf	New York City	Aid-de-camp to Major-General Hancock.
J. S. Wharton	Capt. 19th Inf	do	Do.
G. S. L. Ward	1st lt. 22d Inf	do	Do.
W. M. Wherry	Capt. 6th Inf	West Point, N. Y	Aid-de-camp to Major-General Schofield.
R. F. O'Beirne	Capt. 21st Inf	do	Do.
Frank Michler	1st lt. 5th Cav	do	Do.
B. B. Keeler	Capt. 18th Inf	San Francisco, Cal	Aid-de-camp to Major-General McDowell.
J. H. Coster	Capt. 8th Cav	do	Do.
W. M. Dunn, jr	Capt. 2d Art	Fort Leavenworth, Kans.	Aid-de-camp to Brigadier-General Pope.
C. S. Ilsley	Capt. 7th Cav	do	Do.
W. J. Volkmar	1st lt. 5th Cav	do	Do.
J. A. Sladen	1st lt. 14th Inf	Portland, Oreg	Aid-de-camp to Brigadier-General Howard.
M. C. Wilkinson	1st lt. 3d Inf	In the field, Idaho	Do.
R. H. Fletcher	1st lt. 21st Inf	do	Acting aid-de camp to Brigadier-General Howard.
E. W. Smith	Capt. 18th Inf	Saint Paul, Minn	Aid-de-camp to Brigadier-General Terry.
R. P. Hughes	Capt. 3d Inf	do	Do.
E. B. Gibbs	1st lt. 6th Inf	do	Do.
C. D. Emory	Capt. 9th Inf	San Antonio, Tex	Aid-de-camp to Brigadier-General Ord.
H. G. Brown	1st lt. 12th Inf	do	Do.
J. C. Ord	2d lt. 25th Inf	do	Do.
G. B. Russell	Capt. 9th Inf	New Orleans, La	Aid-de-camp to Brigadier-General Augur.
J. A. Augur	1st lt. 5th Cav	do	Do.
Colon Augur	1st lt. 2d Cav	do	Do.
A. H. Nickerson	Capt. 23d Inf	Omaha, Nebr	Aid-de-camp to Brigadier-General Crook.
J. G. Bourke	1st lt. 3d Cav	In the field, Wyo	Do.
W. S. Schuyler	1st lt. 5th Cav	do	Do.
W. B. Wheeler	2d lt. 18th Inf	Atlanta, Ga	Aid-de camp to Col. T. H. Ruger.
E. D. Thomas	1st lt. 5th Cav	Prescott, Ariz	Aid-de-camp to Col. A. V. Kautz.
G. S. Anderson	1st lt. 6th Cav	do	Do.
Richard Arnold	Maj. 5th Art	New York City	Acting assistant inspector-general, Military Division of the Atlantic.
E. C. Mason	Maj. 21st Inf	In the field, Idaho	Acting assistant inspector-general, Department of Columbia.
A. D. Nelson	Lt. col. 12th Inf	Saint Paul, Minn	Acting assistant inspector-general, Department of Dakota.
J. S. Mason	Lt. col. 4th Inf	San Antonio, Tex	Acting assistant inspector-general, Department of Texas.
W. B. Royall	Lt. col. 3d Cav	Omaha, Nebr	Acting assistant inspector-general, Department of the Platte.
James Biddle	Maj. 6th Cav	Prescott, Ariz	Acting assistant inspector-general, Department of Arizona.
Luke O'Reilly	Capt. 19th Inf	New Orleans, La	Acting judge-advocate, Department of the Gulf.
C. A. H. McCauley	2d lt. 3d Art	In the field	Assistant to chief engineer, Department of the Missouri.
A. M. Raphall	1st lt. 11th Inf	San Antonio, Tex	On special duty at headquarters Department of Texas.
G. W. Davis	Capt. 14th Inf	do	Superintending construction of quartermaster depot.
G. G. Huntt	Maj. 1st Cav	Washington, D. C	Chief disbursing-officer Freedmen's Branch, Adjutant-General's Office.
A. K. Arnold	Maj. 6th Cav	New Orleans, La	Disbursing-officer, Freedmen's Branch.
H. S. Hawkins	Capt. 6th Inf	Louisville, Ky	Do.
S. M. Swigert	1st lt. 2d Cav	In the field	Assistant to chief engineer, Department of the Platte.
E. G. Beckwith	Maj. 2d Art	Washington, D. C	On duty in office of Commissary-General of Subsistence.
W. H. Low, jr	1st lt. 20th Inf	In the field, Mont	Assistant to chief engineer, Department of Dakota.
A. H. Nave	1st lt. 7th Cav	Fort A. Lincoln, Dak	Acting ordnance officer of post.

List of line officers of the United States Army performing staff duties, &c.—Continued.

Name.	Rank and regiment.	Station.	Duty.
J. S. Loud	1st lt. 9th Cav	Santa Fé, N. Mex	Acting assistant adjutant-general, District of New Mexico.
C. A. Stedman	...do	...do	Acting engineer officer, District of New Mexico.
Edward Hunter	1st lt. 1st Cav	Camp McDermit, Nev	Acting assistant quartermaster and acting commissary of subsistence.
F. K. Upham	...do	Fort Walla Walla, Wash. T	Do.
P. S. Bomus	...do	Fort Lapwai, Idaho	Do.
G. B. Bachus	2d lt. 1st Cav	Fort Colville, Wash. T	Do.
W. C. Rawolle	1st lt. 2d Cav	Fort Fred. Steele, Wyo	Do.
J. L. Fowler	...do	Fort Sanders, Wyo	Do.
J. H. Coale	...do	Camp Stambaugh, Wyo	Do.
H. C. La Point	2d lt. 2d Cav	Camp Brown, Wyo	Do.
G. A. Drew	1st lt. 3d Cav	Fort Laramie, Wyo	Acting assistant quartermaster.
R. E. Whitman	...do	Sidney Barracks, Nebr	Acting assistant quartermaster and acting commissary of subsistence.
H. H. Crews	1st lt. 4th Cav	Fort Sill, Ind. T	Do.
W. P. Hale	1st lt. 5th Cav	Fort D. A. Russell, Wyo	Do.
C. D. Parkhurst	2d lt. 5th Cav	Fort McPherson, Nebr	Do.
C. C. Gordon	1st lt. 6th Cav	Camp Grant, Ariz	Acting commissary of subsistence.
D. M. Greene	2d lt. 6th Cav	Camp Bowie, Ariz	Acting assistant quartermaster and acting commissary of subsistence.
L. A. Craig	...do	Camp in Huachua Mountains, Ariz.	Do.
E. E. Dravo	...do	Camp McDowell, Ariz	Do.
G. F. Foote	1st lt. 8th Cav	Fort Brown, Tex	Acting commissary of subsistence.
Edmund Luff	...do	Ringgold Barracks, Tex	Acting assistant quartermaster and acting commissary of subsistence.
Patrick Cusack	1st lt. 9th Cav	Fort Bayard, N. Mex	Do.
J. T. Morrison	1st lt. 10th Cav	Fort Concho, Tex	Acting commissary of subsistence.
S. R. Colladay	...do	Fort Griffin, Tex	Acting assistant quartermaster and acting commissary of subsistence.
G. H. Evans	2d lt. 10th Cav	San Felipe, Tex	Do.
J. W. Dillenback	1st lt. 1st Art	Fort Adams, R. I	Acting commissary of subsistence.
R. G. Shaw	...do	Fort Warren, Mass	Acting assistant quartermaster and acting commissary of subsistence.
Allyn Capron	...do	Fort Trumbull, Conn	Do.
R. H. Patterson	...do	Fort Independence, Mass	Do.
C. L. Best	...do	Fort Preble, Me	Do.
John McGilvray	1st lt. 2d Art	Fort McHenry, Md	Do.
J. L. Mast	...do	Fort Johnston, N. C	Do.
E. M. Weaver, jr	2d lt. 2d Art	Fort Foote, Md	Do.
J. B. Burbank	1st lt. 3d Art	Fort Schuyler, N. Y	Do.
C. W. Harrold	...do	Fort Wadsworth, N. Y	Acting commissary of subsistence.
R. D. Potts	...do	Plattsburg Barracks, N. Y	Acting assistant quartermaster and acting commissary of subsistence.
Sedgwick Pratt	...do	Fort Hamilton, N. Y	Acting commissary of subsistence.
H. C. Danes	...do	Fort Ontario, N. Y	Acting assistant quartermaster and acting commissary of subsistence.
A. T. Abbott	...do	Madison Barracks, N. Y	Do.
Frederick Fuger	1st lt. 4th Art	Presidio, San Francisco, Cal.	Do.
Peter Leary, jr	...do	In the field, Idaho	Acting assistant quartermaster of troops in the field.
William Everett	...do	Fort Canby, Wash. T	Acting assistant quartermaster and acting commissary of subsistence.
H. R. Anderson	...do	Alcatraz Island, Cal	Do.
W. R. Quinan	...do	Point San José, Cal	Do.
J. M. Jones	2d lt. 4th Art	Yerba Buena Island, Cal	Do.
J. A. Fessenden	1st lt. 5th Art	Saint Augustine, Fla	Do.
Frank Thorp	...do	Charleston, S. C	Do.
H. J. Reilly	...do	Fort Barrancas, Fla	Do.
James Curry	...do	Fort Monroe, Va	Acting commissary of subsistence.
G. E. Sage	2d lt. 5th Art	Savannah, Ga	Acting assistant quartermaster and acting commissary of subsistence.
J. R. McAuliffe	...do	Fort Brooke, Fla	Do.
John Hamilton	1st lt. 1st Inf	Fort Sully, Dak	Do.
F. E. Pierce	...do	Fort Randall, Dak	Do.
J. J. O'Connell	2d lt. 1st Inf	Lower Brule Agency, Dak.	Do.
F. H. Edmunds	...do	In the field, Ariz	Do.
S. E. Clark	1st lt. 2d Inf	Atlanta, Ga	Do.
H. B. Sarson	...do	Chattanooga, Tenn	Do.
G. W. H. Stouch	1st lt. 3d Inf	Holly Springs, Miss	Do.
F. B. Jones	...do	Mobile, Ala	Do.
Arthur Williams	2d lt. 3d Inf	Mount Vernon Barracks, Ala.	Do.
G. O. Webster	1st lt. 4th Inf	Fort Fetterman, Wyo	Acting assistant quartermaster.
John Scott	...do	Fort Bridger, Wyo	Acting assistant quartermaster and acting commissary of subsistence.
J. J. O'Brien	2d lt. 4th Inf	Cantonment Reno, Wyo	Do.

List of line officers of the United States Army performing staff duties, &c.—Continued.

Name.	Rank and regiment.	Station.	Duty.
E. L. Randall	1st lt. 5th Inf	Camp on Tongue River, Mont.	Acting assistant quartermaster and acting commissary of subsistence.
Granville Lewis	do	Military Prison, Fort Leavenworth, Kans.	Do.
F. W. Thibaut	1st lt. 6th Inf	Fort Buford, Dak	Acting commissary of subsistence.
D. L. Craft	do	Fort Stevenson, Dak	Acting assistant quartermaster and acting commissary of subsistence.
R. E. Thompson	2d lt. 6th Inf	Saint Paul, Minn	Acting commissary of subsistence.
J. W. Jacobs	1st lt. 7th Inf	Fort Shaw, Mont	Acting assistant quartermaster and acting commissary of subsistence.
C. A. Worden	2d lt. 7th Inf	Fort Ellis, Mont	Do.
E. E. Hardin	do	Fort Benton, Mont	Do.
A. B. Johnson	do	Missoula, Mont	Do.
S. R. Douglas	do	In the field, Mont	Do.
Samuel Craig	1st lt. 8th Inf	Camp Apache, Ariz	Do.
C. A. Earnest	do	Fort Yuma, Cal	Do.
P. H. Ray	do	Camp Lowell, Ariz	Do.
C. M. Bailey	do	Fort Whipple, Ariz	Do.
J. McE. Hyde	2d lt. 8th Inf	Camp Verde, Ariz	Do.
W. L. Pitcher	do	Camp Thomas, Ariz	Do.
Alfred Morton	1st lt. 9th Inf	Omaha Barracks, Nebr	Acting assistant quartermaster.
T. H. Capron	do	Fort Laramie, Wyo	Acting commissary of subsistence.
J. McB. Stembel	2d lt. 9th Inf	Omaha Barracks, Nebr	Do.
T. S. McCaleb	do	North Platte, Nebr	Acting assistant quartermaster and acting commissary of subsistence.
S. H. Lincoln	1st lt. 10th Inf	Fort McKavett, Tex	Do.
W. F. Duggan	do	Fort McIntosh, Tex	Do.
C. E. Bottsford	do	San Antonio, Tex	Do.
Ira Quinby	1st lt. 11th Inf	Cheyenne Agency, Dak	Do.
D. J. Craigie	1st lt. 12th Inf	Camp Halleck, Nev	Do.
J. S. King	do	Camp Mojave, Ariz	Do.
James Halloran	do	Camp Gaston, Cal	Do.
G. W. Kingsbury	do	Angel Island, Cal	Do.
A. G. Tassin	2d lt. 12th Inf	Ehrenburg, Ariz	Acting assistant quartermaster and acting commissary of subsistence of depot.
F. Von Schrader	do	Camp McDermit, Nev	Acting assistant quartermaster and acting commissary of subsistence.
W. W. Witherspoon	do	Camp Independence, Cal	Do.
William Auman	1st lt. 13th Inf	Baton Rouge, La	Do.
H. G. Cavenaugh	do	Little Rock, Ark	Do.
J. A. Olmstead	do	Jackson Barracks, La	Do.
T. S. Mumford	do	Lake Charles, La	Do.
C. H. Warrens	1st lt. 14th Inf	Camp Douglas, Utah	Do.
John Murphy	do	Camp Robinson, Nebr	Do.
Joseph Hall	2d lt. 14th Inf	Fort Hall, Idaho	Do.
J. H. Gustin	do	Fort Hartsuff, Nebr	Do.
S. J. Mulhall	do	Fort Cameron, Utah	Do.
J. W. Bean	1st lt. 15th Inf	Fort Garland, Colo	Do.
S. R. Stafford	do	Fort Wingate, N. Mex	Do.
H. P. Sherman	do	Fort Union, N. Mex	Acting commissary of subsistence.
C. M. De Lany	do	Fort Stanton, N. Mex	Acting assistant quartermaster and acting commissary of subsistence.
W. O. Cory	2d lt. 15th Inf	Fort Selden, N. Mex	Do.
Theodore Smith	do	Fort Craig, N. Mex	Do.
H. C. Ward	1st lt. 16th Inf	Fort Riley, Kans	Do.
G. H. Palmer	do	Fort Wallace, Kans	Do.
G. M. Love	do	Fort Hays, Kans	Do.
T. C. Woodbury	2d lt. 16th Inf	Fort Reno, Ind. T	Do.
T. G. Troxell	1st lt. 17th Inf	Standing Rock Agency, Dak.	Acting assistant quartermaster.
D. H. Brush	do	do	Acting commissary of subsistence
George Ruhlen	do	In the field, Montana	Acting assistant quartermaster and acting commissary of subsistence.
H. P. Walker	2d lt. 17th Inf	Fort A. Lincoln, Dak	Acting commissary of subsistence.
James Brennan	do	do	Acting assistant quartermaster.
C. St. J. Chubb	do	Bismarck, Dak	Acting depot quartermaster and commissary of subsistence.
J. D. Nickerson	do	Fort Sisseton, Dak	Acting assistant quartermaster and acting commissary of subsistence.
W. I. Cook	do	Fort Abercrombie, Dak	Do.
J. H. Baldwin	1st lt. 18th Inf	Columbia, S. C	Do.
John Anderson	2d lt. 18th Inf	Greenville, S. C	Do.
C. W. Williams	do	Morganton, N. C	Do.
J. G. Leefe	1st lt. 19th Inf	Fort Dodge, Kans	Do.
C. A. Vernon	do	Fort Larned, Kans	Do.
C. B. Hall	do	Fort Lyon, Col	Do.
J. A. Payne	2d lt. 19th Inf	Camp Supply, Ind. T	Do.
A. H. M. Taylor	do	Fort Elliott, Tex	Do.
T. W. Lord	1st lt. 20th Inf	Fort Snelling, Minn	Do.
Alfred Reynolds	2d lt. 20th Inf	Fort Totten, Dak	Do.

List of line officers of the United States Army performing staff duties, &c.—Continued.

Name.	Rank and regiment.	Station.	Duty.
F. X. Kinzie	2d lt. 20th Inf	Fort Pembina, Dak	Acting assistant quartermaster and acting commissary of subsistence.
Palmer Tilton	....do	Fort Seward, Dak	Do.
W. F. Spurgin	Capt. 21st Inf	Lewiston, Idaho	Acting depot quartermaster and commissary of subsistence.
T. F. Riley	1st lt. 21st Inf	Fort Boise, Idaho	Acting assistant quartermaster and acting commissary of subsistence.
E. W. Stone	....do	Fort Townsend, Wash. T	Do.
F. H. E. Ebstein	....do	In the field, Ind. T	Acting assistant quartermaster.
Willis Wittich	2d lt. 21st Inf	Fort Klamath, Oreg	Acting assistant quartermaster and acting commissary of subsistence.
C. H. Bonesteel	....do	Camp Harney, Oreg	Do.
E. S. Farrow	....do	In the field, Ind. T	Acting assistant quartermaster and acting ordnance officer.
P. M. Thorne	1st lt. 22d Inf	Fort Wayne, Mich	Acting assistant quartermaster and acting commissary of subsistence.
T. H. Fisher	....do	Fort Mackinac, Mich	Do.
J. M. Gore	2d lt. 22d Inf	Fort Porter, N. Y	Do.
J. G. Ballance	....do	Fort Brady, Mich	Do.
R. I. Eskridge	Capt. 23d Inf	Fort Gibson, Ind. T	Do.
W. F. Rice	1st lt. 23d Inf	Fort Leavenworth, Kans	Acting assistant quartermaster.
Charles Hay	....do	......do	Acting commissary of subsistence.
B. M. Custer	1st lt. 24th Inf	Fort Clark, Tex	Acting assistant quartermaster and acting commissary of subsistence.
W. H. W. James	....do	Fort Duncan, Tex	Do.
H. B. Quimby	1st lt. 25th Inf	Fort Davis, Tex	Do.
H. P. Ritzius	....do	Fort Stockton, Tex	Do.
J. P. Storey	1st lt. 4th Art	Washington, D. C	On signal duty.
R. P. Strong	....do	Fort Whipple, Va	Do.
H. H. C. Dunwoody	....do	Washington, D. C	Do.
Robert Craig	....do	......do	Do.
F. C. Grugan	1st lt. 2d Cav	Fort Whipple, Va	Do.
G. S. Grimes	1st lt. 2d Art	Dennison, Tex	Do.
C. E. Kilbourne	....do	Washington, D. C	Do.
John McClellan	1st lt. 5th Art	Fort Whipple, Va	Do.
T. N. Barber	1st lt. 1st Art	......do	Do.
A. W. Greely	1st lt. 5th Cav	In the field, New Mexico	Do.
J. A. Buchanan	1st lt. 14th Inf	Buffalo, N. Y	Do.
H. W. Howgate	1st lt. 20th Inf	Washington, D. C	Do.
S. C. Vedder	2d lt. 19th Inf	Santa Fé, N. Mex	Do.
Philip Reade	2d lt. 3d Inf	San Diego, Cal	Do.
C. A. Booth	2d lt. 1st Inf	In North Carolina	Do.
James Allen	2d lt. 3d Cav	In Virginia	Do.
F. S. Rice	2d lt. 1st Art	Fort Whipple, Va	Do.
C. A. Tingle	2d lt. 2d Art	In the field	Do.
Rogers Birnie, jr	1st lt. 13th Inf	......do	With United States geographical survey west of 100th meridian.
C. C. Morrison	1st lt. 6th Cav	......do	Do.
M. M. Macomb	2d lt. 4th Art	......do	Do.
Garrick Mallery	Capt. 1st Inf	Washington, D. C	With Powell's survey of Territories.

NOTE.—With but few exceptions the officers reported in the foregoing list as acting assistant quartermasters and acting commissaries of subsistence also performed their appropriate company or regimental duty.

Line officers on duty as professors of military science at colleges June 30, 1877.

Name.	Rank and regiment.	Where on duty.
C. A. L. Totten	1st lt. 4th Art	Agricultural College, Amherst, Mass.
H. W. Hubbell, jr	1st lt. 1st Art	Institute of Technology, Boston, Mass.
W. P. Van Ness	...do	Cornell University, Ithaca, N. Y.
H. B. Osgood	1st lt. 3d Art	Western University, Pittsburgh, Pa.
C. R. Barnett	1st lt. 5th Art	Military Academy, Chester, Pa.
J. M. Lancaster	1st lt. 3d Art	Bishop Seabury Mission, Faribault, Minn.
J. A. Lundeen	1st lt. 4th Art	University of Minnesota, Minneapolis, Minn.
E. T. C. Richmond	1st lt. 2d Art	West Virginia University, Morgantown, W. Va.
L. V. Caziarc	...do	Bowdoin College, Brunswick, Me.
J. E. Myers	2d lt. 3d Art	Cornell College, Mount Vernon, Iowa.
James Chester	1st lt. 3d Art	Iowa State University, Iowa City, Iowa.
Frederick Robinson	1st lt. 5th Art	University of Vermont, Burlington, Vt.
J. S. Rogers	2d lt. 1st Inf	Detroit High School, Detroit, Mich.
J. M. Ingalls	1st lt. 1st Art	Houghton High School, Houghton, Mich.
G. N. Whistler	1st lt. 5th Art	Kentucky University, Lexington, Ky.
J. E. Bloom	1st lt. 4th Art	East Tennessee University, Knoxville, Tenn.
Luigi Lomia	1st lt. 5th Art	Agricultural and Mechanical College, Columbus, Ohio.
F. A. Kendall	1st lt. 25th Inf	Brooks High School, Cleveland, Ohio.
E. S. Dudley	1st lt. 2d Art	University of Nebraska, Lincoln, Nebr.
Joseph Garrard	1st lt. 4th Art	North Georgia Agricultural College, Dahlonega, Ga.
W. P. Vose	1st lt. 2d Art	Mississippi Military Institute, Pass Christian, Miss.
Walter Howe	1st lt. 4th Art	State College, Centre County, Pa.
F. W. Hess	1st lt. 3d Art	Allegheny College, Meadville, Pa.
D. D. Wheeler	1st lt. 1st Art	Asbury University, Greencastle, Ind.
G. G. Greenough	1st lt. 4th Art	University of California, Berkeley, Cal.

Line officers on duty at the Military Academy, West Point, N. Y., June 30, 1877.

Name.	Rank and regiment.	Duty.
T. H. Neill	Lt. col. 6th Cav	Commandant of cadets and instructor of cavalry, artillery and infantry tactics.
Alexander Piper	Major 4th Art	Assistant instructor of artillery tactics.
E. B. Beaumont	Capt. 4th Cav	Assistant instructor of cavalry tactics.
R. H. Hall	Capt. 10th Inf	Adjutant of Military Academy, librarian, &c.
W. M. Wherry	Capt. 6th Inf	Assistant adjutant-general Department West Point; also accounted for as aid-de-camp to General Schofield.
R. F. O'Beirne	Capt. 21st Inf	Disbursing officer Military Academy; also accounted for as aid-de-camp to General Schofield.
S. M. Mills	1st lt. 5th Art	Treasurer and acting assistant quartermaster and acting commissary subsistence for battalion of cadets.
C. P. Miller	1st lt. 4th Art	Acting assistant quartermaster of Academy and post.
L. H. Walker	1st lt. 15th Inf	Assistant instructor of infantry tactics.
A. L. Morton	1st lt. 5th Art	Assistant instructor department of tactics.
A. E. Wood	1st lt. 4th Cav	Do.
W. P. Duvall	1st lt. 5th Art	Acting commissary subsistence and acting assistant professor of mathematics.
E. E. Wood	1st lt. 8th Cav	Assistant professor of French language.
D. D. Johnson	1st lt. 5th Art	Assistant professor of chemistry.
H. A. Reed	1st lt. 2d Art	Assistant professor of drawing.
G. B. Davis	1st lt. 5th Cav	Assistant professor of Spanish language and acting assistant professor of chemistry.
Ira McNutt	2d lt. 3d Art	Assistant instructor department of tactics.
O. L. Hein	2d lt. 1st Cav	Do.
R. A. Ives	2d lt. 5th Art	Assistant professor of law.
C. A. Postley	2d lt. 3d Art	Acting assistant professor of mathematics.
E. Z. Steever, jr	2d lt. 3d Cav	Do.
W. S. Wyatt	2d lt. 9th Inf	Acting assistant professor of chemistry.
Wallace Mott	2d lt. 8th Inf	Acting assistant professor of mathematics.
T. G. Townsend	2d lt. 6th Inf	Acting assistant professor of drawing.
W. H. Coffin	2d lt. 5th Art	Acting assistant professor of French language.
G. F. E. Harrison	2d lt. 2d Art	Do.
O. B. Mitcham	2d lt. 4th Art	Acting assistant professor of Spanish language.
T. H. Bliss	2d lt. 1st Art	Acting assistant professor of French language.

Line officers on recruiting service June 30, 1877.

Name.	Rank and regiment.	Station.	Duty.
J. I. Gregg	Colonel 8th Cav.	Saint Louis barracks, Mo	Superintendent mounted recruiting service.
A. R. Chaffee	Capt. 6th Cav.	New York City, N. Y	In charge of rendezvous.
W. McCleave	Capt. 8th Cav.	Saint Louis barracks, Mo	On duty at depot.
J. G. McAdams	1st lt. 2d Cav.	do	Do.
Emmet Crawford	1st lt. 3d Cav.	do	Do.
L. O. Parker	1st lt. 4th Cav.	Boston, Mass	In charge of rendezvous.
W. C. Forbush	1st lt. 5th Cav.	Saint Louis barracks, Mo	Acting commissary of subsistence at depot.
Byron Dawson	1st lt. 9th Cav.	Indianapolis, Ind	In charge of rendezvous.
S. L. Woodward	1st lt. 10th Cav.	Saint Louis barracks, Mo	Acting assistant quartermaster at depot.
D. S. Stanley	Colonel 22d Inf.	New York City, N. Y	Superintendent general recruiting service.
J. E. Yard	Major 20th Inf.	Columbus barracks, Ohio	Commanding depot.
E. G. Bush	Capt. 10th Inf.	Fort Columbus, N. Y	Do.
W. N. Tisdall	Capt. 1st Inf	Cincinnati, Ohio	In charge of rendezvous.
W. F. Drum	Capt. 2d Inf.	Boston, Mass	Do.
J. F. Kent	Capt. 3d Inf.	New York City, N. Y	Do.
W. H. Powell	Capt. 4th Inf.	Buffalo, N. Y	Do.
Samuel Ovenshine	Capt. 5th Inf.	Baltimore, Md	Do.
E. B. Savage	Capt. 8th Inf.	Saint Louis, Mo	Do.
W. W. Rogers	1st lt. 9th Inf	Indianapolis, Ind	Do.
M. H. Stacey	Capt. 12th Inf.	Jersey City, N. J	Do.
J. T. McGinnis	Capt. 13th Inf.	Cleveland, Ohio	Do.
R. L. Morris	Capt. 18th Inf.	New York City, N. Y	Do.
Lloyd Wheaton	Capt. 20th Inf.	Chicago, Ill	Do.
C. N. Gray	1st lt. 25th Inf.	Nashville, Tenn	Do.
W. W. Daugherty	1st lt. 22d Inf.	New York City, N. Y	Acting assistant adjutant-general to superintendent general recruiting service.
D. M. Lee	Capt. 6th Inf.	Columbus barracks, Ohio	On duty at depot.
Daniel Robinson	1st lt. 7th Inf.	do	Do.
J. E. Quentin	1st lt. 14th Inf.	do	Do.
L. M. O'Brien	1st lt. 17th Inf.	do	Do.
G. K. Spencer	2d lt. 19th Inf.	do	Do.
H. R. Brinkerhoff	1st lt. 15th Inf.	do	Acting assistant quartermaster and acting commissary subsistence at depot.
Charles Bird	1st lt. 23d Inf.	Fort Columbus, N. Y	Do.
W. N. Sage	1st lt. 11th Inf.	do	On duty at depot.
Merritt Barber	1st lt. 16th Inf.	do	Do.
J. M. Ross	1st lt. 21st Inf.	do	Do.

Line officers on miscellaneous detached duty June 30, 1877.

Name.	Rank and regiment.	Station.	Duty.
C. C. Wolcott	1st lt. 3d Art.	Washington, D. C	On duty in Navy Department.
T. G. Pitcher	Colonel 1st Inf.	do	Governor of Soldiers' Home.
T. L. Crittenden	Colonel 17th Inf.	do	Settling Montana and Dakota war claims.
Thomas H. Bradley	1st lt. 21st Inf.	do	On duty in War Department.
G. M. Randall	Capt. 23d Inf.	Red Cloud agency, Dak	On duty in connection with Indian affairs.
J. L. Bullis	1st lt. 24th Inf.	In the field, Texas	Commanding Indian scouts.
R. H. Pratt	1st lt. 10th Cav.	Saint Augustine, Fla	In charge of Indian prisoners.
J. M. Lee	1st lt. 9th Inf.	Spotted Tail agency, Dak	Acting Indian agent.
C. A. Johnson	1st lt. 14th Inf.	Red Cloud agency, Dak	Do.

E. D. TOWNSEND,
Adjutant-General.

ADJUTANT-GENERAL'S OFFICE,
Washington, D. C., February 18, 1878.

45TH CONGRESS, } HOUSE OF REPRESENTATIVES. { Ex. Doc.
2d Session. } { No. 56.

IMPROVEMENT OF THE "GUT" OPPOSITE BATH, ME.

LETTER

FROM

THE SECRETARY OF WAR,

TRANSMITTING

Report of Engineer upon the improvement of the "Gut" opposite Bath, Me.

FEBRUARY 27, 1878.—Referred to the Committee on Commerce and ordered to be printed.

WAR DEPARTMENT,
Washington City, February 26, 1878.

The Secretary of War has the honor to transmit to the House of Representatives, in compliance with the resolution of the 13th instant, report of Lieut. Col. George Thom, Corps of Engineers, as to the necessity of further improvement to the "Gut" opposite Bath, Me., with letter of the Chief of Engineers submitting the same.

GEO. W. McCRARY,
Secretary of War.

The SPEAKER *of the House of Representatives.*

OFFICE OF THE CHIEF OF ENGINEERS,
Washington, D. C., February 25, 1878.

SIR: I have to acknowledge the reference to this office, on the 14th nstant, of the resolution of the House of Representatives of the 13th nstant, "that the honorable Secretary of War furnish to this House nformation as to the necessity of further improvement to the 'Gut' pposite Bath, Me., and the amount of appropriation required for that urpose, said locality having heretofore been surveyed," and in comliance therewith to submit the inclosed copy of a report on the subject rom Lieut. Col. George Thom, Corps of Engineers, to whom it was eferred, and which, it is believed, will afford the desired information.

Colonel Thom says that the improvements heretofore made by the nited States at this locality have benefited the commerce and navigaon so much, and have given such an impetus thereto, that further imrovement is desired. His estimate for this further improvement, which onsists of dredging, widening the passage through Upper Hell Gate,

and breaking up and removing a sunken ledge from the channel on the north and east side of Marsh Island, is $17,000.

The resolution of the House of Representatives is herewith respectfully returned.

Very respectfully, your obedient servant,

A. A. HUMPHREYS,
Brigadier-General and Chief of Engineers.

Hon. GEORGE W. MCCRARY,
Secretary of War.

UNITED STATES ENGINEER OFFICE,
Portland, Me., February 21, 1878.

GENERAL: I have the honor to acknowledge the receipt of department letter of the 15th instant, furnishing for my information and a report, the resolution of the House of Representatives, of February 13, 1878, calling upon the honorable Secretary of War for "information as to the necessity of further improvement to the 'Gut' opposite Bath, Me., and the amount of appropriation required for that purpose, said locality having heretofore been surveyed," and, in compliance therewith, to report as follows:

"The Gut," so called, is a part of Back River, which is a tidal river about nine miles in length connecting the Kennebec River at Bath, Me., with the tidal waters of the Sheepscot River to the eastward of it. It is navigable for small steamers and other vessels of light draught, and affords a short communication between the Kennebec River and the towns of Westport, Wiscasset, Boothbay, Southport, and other places on and near the waters of the Sheepscot. At "the Gut" (or more commonly called the "Upper Hell Gate"), which is about two miles distant from the city of Bath, the navigation of this river has already been very much improved in its most difficult places under appropriations made therefor, by Congress, in 1870 and 1871, amounting to $16,500. On referring to my annual report of 1873, it will be seen that these appropriations have been applied to—

1. The breaking up and removal of Boiler Rock (a large and very dangerous rock in mid-channel at the Upper Hell Gate,) so as to have a depth of 10 feet at mean low-water, or 16½ feet at mean high-water.

2. The breaking up and removal of a ledge between Boiler Rock and the north shore, to a depth of 9 feet at mean low-water.

3. The removal of two wrecks of vessels lying in mid-channel above and near Upper Hell Gate.

4. Dredging a channel through the bar next above Upper Hell Gate to a width of 100 feet, and a depth of 10 feet, at mean low-water, or 16½ feet at ordinary high-water.

5. The breaking up and removal of points of ledge which projected into the river from its southern shore at the Upper Hell Gate, whereby its water-way has been much increased, and the velocity of the currents much diminished. This work was completed in 1872; and the improvements have benefited the commerce and navigation of this river to such an extent, and have given such an impetus thereto, that those who are interested therein are now very desirous of having more work done for its further improvement, as follows, viz: 1st, to have the shoal next above Upper Hell Gate excavated to a depth of 12 feet at mean low-water; 2d, to have the passage through Upper Hell Gate opened to a still greater width so as to diminish the velocity of the current; and,

3d, to have some projecting points of ledges and sunken rocks below Boiler Rock, broken up and removed so as to render safe and practicable the direct channel on the northward and eastward of Marsh Island and thereby avoid the present crooked channel south of the island.

In the absence of special surveys to ascertain with great accuracy the extent and probable cost of this additional work for the further improvement of this river at the Gut (so called) opposite Bath, Me., the following approximate estimate of cost is submitted, viz:

1. For dredging shoal above Upper Hell Gate to a depth of 12 feet at mean low-water, 20,000 cubic yards, at 30 cents per cubic yard	$6,000 00
2. Widening the passage through Upper Hell Gate, 1,000 cubic yards of ledge excavation, at $4 per cubic yard	4,000 00
3. Breaking up and removing 160 cubic yards of sunken ledge from the channel on the north and east side of Marsh Island, at $35	5,600 00
4. For engineering expenses and other contingencies, say	1,400 00
Total	17,000 00

On making inquiry of those who are best informed in regard to the nature and extent of the navigation and commerce of this river and to what extent the public interests would be benefited by the further improvement of the river as proposed, the following information has been received, viz: "This is the principal route of travel to and from the towns of South Bristol, Boothbay, Southport, Westport, and Georgetown. The growth of the oil and fishing business has added largely, during the past ten years, to the population and business of these towns, more especially to Bristol and Boothbay; and the latter place is most extensively resorted to by pleasure travelers in the summer season. The Eastern Steamboat Company has for several years run a line of boats between Bath and Boothbay, running two steamers daily during the summer season, and one daily for the rest of the year. Their business amounts to 20,000 to 22,000 passengers each season, and the principal mails go by them. During the summer months a steamer runs from Augusta to Boothbay by this route. Coasting vessels bound east from the Kennebec, if not of too large size, use this passage as it lessens the distance very materially. All the traffic between the towns on the Kennebec and those mentioned above, which is very considerable, goes by this route.

The large lumber mills at Wiscasset and Westport are supplied with logs from the Kennebec, which all go through Hell Gate passage by means of tug-boats.

Very respectfully, your obedient servant,

GEO. THOM,

Lieutenant-Colonel of Engineers, Bvt. Brig. Gen., U. S. A.

Brig. Gen. A. A. HUMPHREYS,

Chief of Engineers, United States Army, Washington, D. C.

PROPOSED BRIDGE OVER THE SAGINAW RIVER.

LETTER

FROM

THE SECRETARY OF WAR,

TRANSMITTING

Report relative to bridge proposed to be constructed over the Saginaw River.

FEBRUARY 28, 1878.—Referred to the Committee on Commerce and ordered to be printed.

WAR DEPARTMENT,
Washington City, February 28, 1878.

The Secretary of War has the honor to transmit to the House of Representatives, in response to the resolution of the House, dated February 5, 1878, a copy of a report of Maj. F. Harwood, Corps of Engineers, relative to the bridge proposed to be constructed over the Saginaw River, at East Saginaw, Mich., with letter of the Chief of Engineers submitting the same.

GEO. W. McCRARY,
Secretary of War.

To the SPEAKER *of the House of Representatives.*

OFFICE OF THE CHIEF OF ENGINEERS,
Washington, D. C., February 27, 1878.

SIR: I beg leave to return herewith the preamble and resolution of the House of Representatives of the 5th instant, in relation to the construction of a bridge across the Saginaw River, within the limits of the city of East Saginaw, and requesting the Secretary of War to inform the House "whether said proposed bridge will, if built, cause an obstruction to the navigation of said river," which was referred to this office, and, in order to comply with its provisions, to submit herewith a copy of a report on the subject from Maj. F. Harwood, Corps of Engineers, the officer in charge of the improvement of that river.

Major Harwood has given the question due consideration, and his report will afford all the information attainable in reference to it. He is of opinion that the proposed bridge will obstruct the navigation of the river, particularly as regards the passage of tows. There are three

other bridges which offer much more serious obstructions, however, to navigation than that proposed to be built, and this latter, except from its proximity to the Genesee-street bridge, he thinks, would not be more objectionable than any of the other five bridges now spanning the Saginaw River.

Very respectfully, your obedient servant,

A. A. HUMPHREYS,
Brigadier-General and Chief of Engineers.

Hon. GEO. W. MCCRARY,
Secretary of War.

BRIDGE PROPOSED TO BE CONSTRUCTED OVER THE SAGINAW RIVER WITHIN THE LIMITS OF EAST SAGINAW, MICH.

UNITED STATES ENGINEER OFFICE,
Detroit, Mich., February 20, 1878.

GENERAL: Upon receipt of your instructions of the 7th instant, to make an early and detailed roport upon the subject-matter of the preamble and resolution of the House of Representatives dated February 5, 1878, and relating to the proposed construction of a bridge over the Saginaw River, within the limits of the city of East Saginaw, I immediately instituted a careful investigation of the matter in question, and now have the honor to embody the result of my inquiry in the following report.

The city of East Saginaw, with a population of about 17,000 inhabitants, having by a popular majority of 662, in a total vote of 1,456, demanded a free bridge over the Saginaw River, traversed at present only by means of toll-bridges, the city authorities have taken active measures for the establishment of such a bridge, which is the one called into question by the resolution of the House of Representatives, upon which I am called upon to report. The bridge is now under contract, and work upon it is expected to begin within a few days from this date.

It is proposed to be located at the foot of Johnson street, East Saginaw, at a distance of 871.32 feet from the Genesee-street foot and wagon toll-bridge, immediately above it, and 2,479 feet from the Flint and Père Marquette Railroad bridge, which is the next bridge below the proposed site. The Saginaw River is at present bridged five times within a distance of 2.538 miles, comprised within the corporate limits of East Saginaw and Saginaw City, either or both. These bridges may be enumerated as follows, beginning up stream and following down—

1st. Mackinaw-street bridge, a highway toll-bridge, connecting Mackinaw street, in Saginaw City, with the southerly wards of East Saginaw.

2d. Bristol-street bridge, 4,900 feet farther down stream, commonly called Middle bridge, a highway toll-bridge connecting Bristol street, East Saginaw, with Saginaw City.

3d. Emmerson-street bridge, 2,450 feet down stream from Bristol-street bridge, a railway bridge not in use, and of which the draw stands constantly open, but which it is understood to be the purpose of those interested to establish as a free highway-bridge in the event of failure to establish the proposed new bridge at Johnson street, now in question.

4th. Genesee-street bridge, 2,700 feet down stream from the Emmerson-street bridge, a highway toll-bridge connecting the mercantile center of East Saginaw with the northerly suburbs of Saginaw City. This bridge is at present the main avenue of communication across the river at East Saginaw.

5th. The Flint and Père Marquette Railway bridge, 3,350 feet down stream from the Genesee-street bridge, used exclusively for the traffic of the Flint and Père Marquette Railway, and the draw of which is kept open excepting during the passage of railway trains.

All these bridges were, from time to time, built under the laws of the State of Michigan, their location being approved by the supervisors of Saginaw County, and their draw-dimensions uniformly regulated by law. Each has a pivot-draw, with draw-intervals of not less than seventy feet in the clear, for the accommodation of general commerce; and adjacent to one or the other of the draw-spans what is known as a rafting-span, one hundred and fifty feet in the clear, for the accommodation of the rafting interest.

Turning now from these general statistics to the particular reach of the river called in question by the proposed construction of a bridge at Johnson street, there is first to be noted that, between the Genesee-street bridge on the one hand and the Flint and Père Marguerritte Railway bridge on the other. there is a clear straight reach of river of unvarying regimen, bounded on either hand by nearly parallel lines of docks. The sketch herewith appended, showing the location of the several bridges hereinbefore mentioned, which is taken from a printed map of East Saginaw, reproduces an error in that map as regards the reach, and does not show the dock-lines with the uniform front they actually present.

The flow of the river through this reach is uniformly varied according to the state of the current, the axis of which is nearly coincident with the axis of the river in the reach, until it strikes a middle-ground which crops out below the site of the proposed bridge. Between this site and Genesee-street bridge there is a clear and unobstructed water way, of nearly uniform depth from bank to bank, varying from about 10 to about 14 feet, as shown by a sketch furnished by the city surveyor of East Saginaw, which is herewith appended.

The relative dimensions and positions of the piers and spans of the Genesee-street bridge and those of the proposed Johnson-street bridge will evidently have an important bearing on the question of to what extent additional obstructions to navigation would be offered by the latter.

The city authorities of East Saginaw, with eminent wisdom, and apparently with a view to reducing to a minimum whatever obstructions may be unavoidable, have decided, in the proposed new bridge, to follow exactly in plan the trace of the Genesee-street bridge, immediately above. We have, therefore, for comparison, in studying the question of obstruction, the following data:

Width of river between the dock-lines at the Genessee-street bridge	434 feet.
Width of river between the dock lines at Johnson street	465 feet.

BRIDGE-DIMENSIONS.

Genesee street.

East approach, Water street to dock-line	148 feet.
Swing	191½ feet.
East span (rafting-span)	150 feet.
West span	62 feet.
West approach	183 feet.

Johnson street.

East approach, Water street to dock-line	148 feet.

Swing	192 feet.
East span (rafting-span)	150 feet.
West span	{ 150 / 100 } feet.
West approach	198 feet.

It is thus seen that the river-faces of the abutments and the axis of the piers of the respective bridges, being in prolongation of each other severally and in direction parallel to the axis of this straight reach of river, whatever obstruction may be offered by any abutment or pier of the proposed new bridge, in that section of the bridge which will be commonly passed in navigation, is covered by the corresponding abutment or pier of the Genesee-street bridge, immediately above, and the sluing influence on hulls of pier-eddies and reflux currents incidental to the interposition of bridge-piers and abutments is in this case reduced to a minimum.

In considering the question of probable obstruction incidental to the interposition of this proposed new bridge at the foot of Johnson street, we are called upon to study it in the light of the two separate and distinct methods of passing bridges practiced by rafts of logs on the one hand and tows of vessels on the other. The rafting interest and the vessel and barge interest are affected in entirely dissimilar manners by bridge obstructions.

To pass a raft of logs through a bridge (and these rafts are some of them hundreds of feet in length and extremely difficult to handle) the tug which has the raft in tow throws off her line just as the raft is about to enter the rafting-span of the bridge.

The raft, thus abandoned to the current and proceeding with a velocity due to it and the living force imparted by the tug before casting loose, proceeds on its way undeviatingly, while the tug, passing the draw, meets the raft again as its head emerges from the rafting-span on the opposite side of the bridge, makes fast the line again and resumes towing. With very long rafts, however, and particularly when the current is swift, the tail of the raft does not always pass the bridge intact, but, notwithstanding every precaution and all the skill and energy of the tenders, will double up, and, engaging on the ice-breakers of the piers, the raft is broken up and logs more or less in number go adrift.

It is true that most of these logs are recovered, but not without a considerable expenditure of time and money, all of which goes to enhance the cost of log-running and is prejudicial to the timber interests generally. It would, then, naturally appear that every additional bridge would be an additional obstacle to the log-runners. On the contrary, however, Mr. A. P. Brewer, an expert in log-running—having been a contractor in that business for many years—testifies that, as a general rule, he finds the bridge-piers an accommodation instead of a hinderance, in that they act as sheer-booms in straightening out the raft. From this point of view, the proposed Johnson-street bridge being only 871.32 feet from the Genesee-street bridge, it would appear that a raft once passing safely either bridge would, by the fender-action of the piers of that bridge, be so straightened out that before it could again begin to double it would have passed the rafting-span of the other in safety. I therefore conclude that in the matter of passing rafts no material addition to obstructions already existing would be offered by the proposed Johnson-street bridge.

With regard, however, to the passage of tows of vessels, and more especially tows of two or more of the unwieldy lumber-barges commonly navigating the Saginaw River, the case is to my mind somewhat

different. It is well known in fact, and readily accounted for, that with every vessel in a tow immediately after passing a bridge there is a tendency to sheer, which tendency must be met by a vigorous use of the helm and lively handling of the tug having control of the tow. Nor can this action of the eddy and reflex current, produced by bridge-piers, be always effectively counteracted at once, particularly in the case of a tow of several large lumber-barges, vessels particularly difficult to handle, and unusually slow in minding their helm. It is a question in my mind whether, with these bridges situated so closely together, it will be possible for a barge, having taken a sheer in passing one, to be gotten under control before passing the draw of the other, and unless she does enter the second draw straight, owing to her great bulk, damage is certain to occur either to the vessel or the bridge, or both. It does certainly appear to me, then, that the Johnson-street bridge is likely to act as an obstruction to navigation in this manner. If, then, this be the case, the next important point is to know how many vessels, in the course of a season, are apt to be imperiled in this manner.

In answer, I respectfully refer to the statement of the keeper of the Genesee-street bridge, appended and marked "A," by which it appears that 5,538 vessels of all classes, excluding rafts, passed his bridge from April to December (inclusive), 1877.

Of course, all of these vessels were not of a character to be particularly imperiled in passing a draw, but this statement will form a basis upon which the honorable Secretary of War may form a judgment as to what amount of commerce would be more or less affected by the establishment of the bridge in question.

The only remaining manner that occurs to me in which the proposed bridge could become an obstacle to navigation, would be by the formation of bars at the tail of its piers. This not having occurred to any appreciable extent in the case of the Genesee-street bridge, and the initial conditions at Johnson-street being entirely similar, I do not consider any such objectionable formation to be at all probable, particularly as the piers of the proposed bridge in the position of the water-way most navigated are located so judiciously that the probability of any such action in conjunction with that of the piers of the Genesee-street bridge is reduced to a minimum.

Having then viewed the matter in every respect, I have to conclude that while in the abstract every bridge is more or less an obstruction to navigation—while the more bridges there are to a given reach of river the greater the degree of obstruction, and while the nearer any two bridges are to each other, within certain limits, the more difficult the passage of the two by tows will be—there are nevertheless, in the particular instance upon which I am called upon to report, certain modifying circumstances which bring the matter to judgment in a different light than that in which it would appear if only to be dealt with in the abstract.

I also found at the very beginning of my investigation the matter in question so encumbered with local issues, with which, of course, it is not my province to deal, that it was almost impossible to get unbiased evidence bearing on points of engineering, whereby to form a professional conclusion on the subject forwarded to me for report which should not bear the impress of the existing local agitation.

I trust that the data and conclusions contained in this report will enable the Hon. Secretary of War to form a clear judgment of the merits of the case from an engineering point of view. The obstructions to navigation offered by the five bridges, heretofore enumerated, traversing the river within a distance of 2,538 miles, are already formidable.

Whether the addition of another bridge will form any material addition to the existing obstacles to navigation is an open question. Whether the location of this bridge in the immediate vicinity of the Genesee-street bridge is particularly objectionable in an engineering point of view is also a question of like character. There is much to be said on both sides of each of these questions, and in this report I have endeavored faithfully to present every point which could possibly throw light on any portion of the subject.

In conclusion, I have only to say, that, of the five existing bridges, three at least appear to me much more objectionable than the one proposed to be built, considered either by itself or in connection with its near neighbor, the Genesee-street bridge. I refer (see tracing herewith appended) to the Mackinaw-street bridge, on account of position in a curve, with projecting docks below; to the Emmerson-street bridge, situated in a curve, where long tows have to approach from up-stream on a curve, and obliquely to the axis of the bridge, and to the Flint and Père Marquette Railway bridge, which is situated just above a formidable bar, which must be turned on a short curve, immediately after passing the bridge, in going down stream.

The proposed Johnson-street bridge, on the other hand, is located in a clear, straight reach, with its piers and draws admirably distributed, so as to offer the least possible obstruction to navigation.

When we consider the much more formidable obstacles to navigation presented in the Saginaw River, below the government improvements near East Saginaw, by booms and piles, occupying in some cases the very axis of the navigable channel, and also reflect upon the fact of the present existence in the immediate vicinity of the proposed bridge of several neighboring obstructions more objectionable than the one which it is alleged would be interposed by its construction at a site above the government improvements, it does certainly appear that if the matter in question could be divested of the fictitious importance lent it by the magnitude of the local issues involved, it would fade into utter insignificance as regards any bearing upon the interests of the general government in the river improvement, and the question of the bridge as an obstruction to navigation would resolve itself into one rather of local than of national importance. These contending local interests, of great magnitude in themselves, insist, nevertheless, upon demanding a hearing in the form of the several papers addressed to the honorable Secretary of War, and marked from B to E inclusive, which are herewith respectfully forwarded, although not remarked upon in this report, having only an incidental bearing upon the subject in that relation in which I am called upon to make report.

The opposite view will be presented in a few days by his honor the mayor of East Saginaw, in a communication which he signified to me to-day his intention of forwarding at the earliest possible opportunity.

The total amount heretofore appropriated for the improvement of Saginaw River has been $151,500, all of which has been applied to the work, save a small balance still on hand to defray current office-expenses. A further appropriation of $50,000 has been asked for to complete the work.

I have the honor to be, general, very respectfully, your obedient servant,

F. HARWOOD,
Major of Engineers.

Brig. Gen. A. A. HUMPHREYS,
Chief of Engineers, U. S. A.

C

45TH CONGRESS, 2d Session. } HOUSE OF REPRESENTATIVES. { Ex. Doc. 57, Part 2.

BRIDGING THE SAGINAW RIVER.

LETTER

FROM

THE SECRETARY OF WAR,

TRANSMITTING

Report of engineer upon bridging the Saginaw River at East Saginaw, Mich.

MARCH 7, 1878.—Referred to the Committee on Commerce and ordered to be printed.

WAR DEPARTMENT,
Washington City, March 6, 1878.

The Secretary of War has the honor to transmit to the House of Representatives, for the Committee on Commerce, in connection with the report of Major Harwood, Corps of Engineers, upon the subject of bridging the Saginaw River at East Saginaw, transmitted to the House of Representatives by letter of the 28th, two communications from the mayor of East Saginaw, Mich.

GEO. W. McCRARY,
Secretary of War.

To the SPEAKER *of the House of Representatives.*

UNITED STATES ENGINEER OFFICE,
Detroit, Mich., February 25, 1878.

GENERAL: I have the honor to forward herewith two communications, marked F and G, addressed to the honorable Secretary of War by his honor the mayor of East Saginaw, Mich., concerning the construction of the proposed bridge over the Saginaw River at East Saginaw, and respectfully request that they may be appended to my report of the 20th instant, as relating to the matter therein reported upon.

I am, general, very respectfully, your obedient servant,

F. HARWOOD,
Major of Engineers.

Brig. Gen. A. A. HUMPHREYS,
Chief of Engineers, United States Army, Washington, D. C.

[Indorsement.]

OFFICE OF CHIEF OF ENGINEERS,
March 2, 1878.

Respectfully forwarded to the honourable the Secretary of War, in connection with report submitted February 27 last, upon the subject of bridging the Saginaw River at East Saginaw, Mich., and with the suggestion that it be sent to the House of Representatives for the information of the Committee on Commerce.

A. A. HUMPHREYS,
Brigadier-General and Chief of Engineers.

F.

MAYOR'S OFFICE,
East Saginaw, Mich., February 23, 1878.

SIR: By a resolution of the House of Representatives passed February 6, your department was requested to report whether a certain proposed bridge across Saginaw River would obstruct the navigation of that stream. The resolution declares that certain parties in this city intend to construct this bridge. This is an error. It is not a private undertaking inaugurated for the benefit of some private individual or corporation. It is to be built by this city, and is to be owned and maintained by the city as a *free bridge* for the perpetual use and benefit of the public.

This city numbers some 18,000 inhabitants, and when the question of building this bridge was submitted to the electors at a special election, the proposition was carried by a vote of two to one, and the only opposition at that time come from persons who believed that it was not good policy for the city to incur the expense of maintaining such a bridge. To-day there is absolutely no opposition whatever.

This city has a vital interest in the navigation of the Saginaw River. It is largely interested in the manufacture of salt and lumber, the bulk of which products seek a market by the way of this river. And yet you will see by the accompanying papers that the manufacturers of lumber and salt, ship owners, shippers, and vessel captains residing here, favor the construction of this bridge. The truth is that it is not a question of obstructing navigation but of maintaining a *free bridge;* all the opposition comes from persons directly or indirectly interested in the maintainance of *toll bridges.* The merits of that controversy I shall not discuss. I would, however, suggest that if private individuals or corporations have any grievances that ought to be remedied the State courts are open to them, having ample jurisdiction in this class of cases. Let them apply there and not seek to make a cat's paw of the general government.

I understand very well that every bridge across a navigable stream obstructs navigation. This proposed bridge will not be an exception in that regard. But we have already three toll bridges and two railroad bridges across the river at this point, and the proposed bridge will be less of an obstruction than either of those now built. No opposition was ever made to the construction of those bridges. I trust the government will leave this controversy to be settled in the local courts, by those who,

from their situation, can obtain knowledge of all the surrounding facts and circumstances.

Your obedient servant,

B. M. THOMPSON,
Mayor of East Saginaw.

Hon. GEORGE W. MCCRARY,
Secretary of War.

To the Hon. GEO. W. MCCRARY,
Secretary of War, Washington, D. C.:

We, the undersigned, vessel owners or doing business on the Saginaw River, are in favor of the construction of the proposed bridge across Saginaw River, at the foot of Johnson street, in the city of East Saginaw, Mich.

We do not believe that said bridge will be a serious impediment to the navigation of said river.

Name.	Residence.	Number of vessels.
E. F. Gowhl	East Saginaw	Two vessels.
Captain J. Dombley	do	Do.
Captain J. J. Corbin	do	
Captain Thomas McKee	do	One vessel.
Captain Ed. Haloch	do	
Captain William Blyhen	do	
Captain A. A. Rouse	do	
Captain J. W. Price	do	
Captain I. Pierce	do	
Captain J. Q. Anderson	do	
Captain J. Dines	do	
Captain Z. Lapham	do	One vessel.
Captain F. E. Clark	do	
Captain Cha. Sonsmith	do	Do.
Captain Cha. Lennox	do	
Captain G. Stewart	do	Do.
Captain B. Oggden	do	Do.
Captain T. Stemert	do	Do.
Captain B. B. Buckhont	do	Do.
Captain J. Myles	do	Do.
Captain C. Saiger	do	Do.
Captain John Howard	do	Two vessels.
Captain William Abel	do	
Captain James Memer	do	One vessel.
Captain John Boltwick	do	Do.
Captain William Brown	do	
Captain John Steuart	do	Do.
Captain —— Brant	do	Do.
Captain Thomas Faulks	do	
Captain Ed. Bunton	do	
Captain Andrew Lansway	do	

All the signers above who are not vessel owners have command of vessels. Where there is no remark opposite the name, the person is a commander and not an owner.

B. M. THOMPSON,
Mayor of Saginaw.

To the Hon. GEO. W. MCCRARY,
Secretary of War, Washington, D. C.:

We, the undersigned, commission men and shippers of lumber and salt, doing business on the Saginaw River, are in favor of the construc-

tion of the proposed bridge across Saginaw River, at the foot of Johnson street, in the city of East Saginaw, Mich.

We do not believe that said bridge will be a serious impediment to the navigation of said river.

Name.	Residence.	Amount of timber shipped.
		Feet.
D. F. Rose	East Saginaw	40,000,000
J. J. Winsor	......do	10,000,000
G. A. Mitchell	......do	10,000,000
A. B. Passage	......do	8,000,000
L. P. Mason	......do	50,000,000
Louis Gueinn	......do	5,000,000
E. S. Catlin	......do	10,000,000

To the Hon. GEO. W. MCCRARY,
Secretary of War, Washington, D. C.:

We, the undersigned, mill-owners and lumber men, doing business on the Saginaw River, are in favor of the construction of the proposed bridge at the foot of Johnson street, in the city of East Saginaw, Mich.

We do not believe that said bridge will be a serious impediment to navigation on said river.

Names.	Residence.	Amount of lumber manufactured.
		Feet.
D. W. Rust	East Saginaw	14,000,000
Shaw & Williams	......do	12,000,000
John Welch	......do	5,000,000
A. W. McCormick	......do	4,000,000
R. G. Horr	......do	5,000,000
Hill Brothers	Saginaw City	8,000,000
William Callam	......do	5,000,000
E. G. Goddard	East Saginaw	2,000,000
J. P. Kroll	......do	7,000,000
C. K. Eddy	......do	6,000,000
Warner & Eastman	......do	10,000,000
George N. Hauptman	......do	11,000,000
Duncan & Gamble	......do	6,000,000
W. R. Burt, sr	......do	15,000,000
Charles Merrill & Co	......do	12,000,000
John McEwan	Bay City	10,000,000
O. E. Elsernon	East Saginaw	3,000,000
William Boenig	......do	4,000,000
Wylie Brothers	......do	5,000,000
James Tolbert	......do	6,000,000
W. J. Barton	......do	6,000,000
L. W. McLeweson	Bay City	13,000,000
T. A. O'Donnell	East Saginaw	5,000,000
L. A. Clark		5,000,000
T. E. Dorr	East Saginaw	3,000,000
Sanborn & Bliss	......do	10,000,000
E. F. Gowlit		10,000,000
J. H. Hill & Sons	Saginaw City	10,000,000

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LOSS OF THE STEAMER METROPOLIS.

LETTER

FROM

THE SECRETARY OF THE TREASURY,

TRANSMITTING

Report of Life-Saving Service in reference to the loss of the steamer Metropolis.

MARCH 1, 1878.—Referred to the Committee on Commerce and ordered to be printed.

TREASURY DEPARTMENT, *February* 28, 1878.

SIR: I have had the honor to receive the House resolution, dated the 25th instant, calling for the report of Captain Merryman, of the Life-Saving Service, in reference to the loss of the steamer Metropolis on the North Carolina coast, and in reply I transmit herewith a copy of the report referred to, and its inclosures.

Very respectfully,

JOHN SHERMAN,
Secretary.

Hon. SAMUEL J. RANDALL,
Speaker of the House of Representatives.

UNITED STATES LIFE-SAVING SERVICE,
February 9, 1878.

SIR: Immediately upon the receipt of your instructions of the 1st instant (S. I. K.), I started for the scene of the disaster to the steamship Metropolis, on Currituck Beach, and, arriving there on the morning of the 3d instant, proceeded at once to make the required investigation of the circumstances attending the said disaster; and, continuing the inquiry until the morning of the 5th instant, I have the honor to submit the following report.

The last of the survivors having left the beach for Norfolk on the 2d instant, I was unable to obtain authentic information as to occurrences on board the Metropolis previous to her discovery by persons on shore, and was therefore confined to information and testimony obtained from the crew of life-saving station No. 4, and other persons in the vicinity who were present and engaged in rescuing and caring for the survivors. From the testimony the following facts appear:

The wreck was first discovered about 8 a. m., January 31, by N. E. K. Jones and James E. Capps, who happened to be on the beach. A fog enveloped the coast at the time through which they caught a glimpse of a mast, but could form no idea of the character of the vessel until they got opposite her, when they saw but one mast standing and that there were many people on board. Jones at once dispatched Capps to notify S. C. Brock, the nearest neighbor, about half a mile back on the sound shore, get his horse, and ride to station No. 4 with the news. Soon after Capps left, Jones discovered several persons struggling in the water near by, and one or two further up the beach among the *débris* of the wreck already breaking up, although stranded but little more than an hour. Jones at once engaged in hauling persons out of the surf, and had thus brought out six or eight when Mr. Brock rode by on his way to the station about 4½ miles northward. Capps had notified him, and getting back to the beach at about half past nine, found the vessel much torn up, the sea breaking all over her, one mast standing "with sail set on it." It is quite impossible to determine with accuracy the time of day of the various occurrences, as on such occasions great excitement prevails and pocket time-pieces are rarely carried by the fishermen, while the clocks in the dwellings are seldom correct. Perhaps the only accurate time-piece on Currituck is at the light-house, and the keeper Mr. Burris, testifies that he was informed of the wreck about 10 a. m., by a messenger from the Light-House Club "nearly half a mile below," at which some of the survivors had arrived, and he believes before the life-saving station was notified. He started for the wreck with his two assistant light-keepers, and on his way was overtaken by the crew of the station with the mortar apparatus. This corroborates the statement of Keeper Chappel that he received intelligence of the wreck about 10 a. m., although Mr. Brock thought it about 8.30 when he reached the station, while the master of the Metropolis reported that Brock did not make his appearance on the beach until 11 a. m. It seems to be generally conceded, however, that the mortar apparatus was on the ground about noon.

The keeper was out on the beach at the moment of Brock's arrival, but soon returned and found his crew preparing for the work before them. Brock states he (the keeper) "asked me if I thought he could get his boat down there in time; I told him I did not, the distance being great and the vessel fast breaking up. He then put the mortar apparatus in the hand-cart and taking the medicine-chest, he and I started for the wreck, leaving the crew to follow with the apparatus."

In order to appreciate the difficulty which the six men encountered in hauling the mortar-cart and load, it must be remembered that station 4 is situated on a portion of the coast so flat for nearly a mile inland, and so slightly above ordinary high water, that the storm-tides sweep over it, and, surrounding the station, cover the sandy plain to a depth of several inches, and this had occurred the night before, making the sand so soft and yielding that the wheels of the cart, with their broad tires, five inches wide, cut four or five inches below the surface, while the feet of the men, as they labored with their load, sank in the sand at every step; consequently the party could make but slow progress. The cart contained the mortar, three balls, the whip-line and block, the breeches-buoy, a tackle, powder-flask, quick-matches, match-rope, and line-stock, line-box, and a Merriman life-saving suit, which, with the cart, made a dead weight of more than 1,000 pounds, 166 pounds to each man. (Standard authorities give the draught of man at 150 pounds over a firm, level road, and say that a porter can transport, in a wheelbarrow, 150 pounds

10 miles a day.) These men were not fresh, as within the preceding twenty-four hours one of them had walked 32 miles through the storm on the north patrol, another 24 miles on the south, while two others had walked 16 miles each and the remaining two 12 miles each. Frequent halts were therefore imperative. The wonder is that they got the apparatus to the wreck so soon as they did. It could not have been done had they not been overtaken about a mile and a half from the station by Mr. John J. Dunton with his horse and cart. He states, "They (the crew) were worn down, it being a bad beach for men to travel, and asked me for assistance. I hitched on to the cart and was glad to do so. We arrived at the wreck about 12 o'clock."

The mortar was immediately got into operation. The statements vary somewhat as to the number and order of the shots fired, which is not remarkable, as on such occasions exciting events so quickly follow each other that comparatively cool and collected men fail to recall them in their exact sequence.

The testimony of the crew of the life-saving station as to the order of the firings is probably the most reliable, as it is concurrent, and the apparatus was under their management. The first shot was at high elevation, the distance to the wreck being overestimated. The ball well aimed to windward, fell far beyond the wreck, while the line was bowed upward high above the fore-truck of the only spar left standing, and, swayed by the wind, fell clear of the spars of the fore mast and across that portion where the main mast had stood, and to the leeward of the wreck, into the sea, the wind being from the southward. The steamer was lying nearly head on to the mortar party, and her extreme beam being 34 feet, she presented a comparatively small object at the distance of 100 yards, over which to cast a line. However familiar or skillful the station-men may be in the use of the mortar, the failure of the first shot is not unusual, as the distance to be reached and the force of the wind are difficult to estimate. The result of the first shot in this instance enabled better success in the second attempt, for the line was then lodged on the port fore-topsail yard-arm. A man said to be the second mate was seen to go aloft, and laying out on the yard (the topsail was still set and aback) got the shot-line from the yard-arm and carried it into the slings of the yard, when he hauled in the slack from shoreward and dropped it to the deck, where it was seized by persons standing on the starboard side of the hurricane-deck, their only remaining foot-hold, as the after part of the vessel together with a great portion of the port side was already gone, while the extreme forward part of the vessel was seen to be moving independently of the remaining portion. The whip-line was at once made fast to the shot-line by the life-saving men and was hauled toward the ship.

It was now observed from the beach that the shot-line lay across the jib-stay; that is, leading outside the stay around its port side and at a sharp angle aft, to the starboard side of the wreck. The angle became more acute as the whip progressed toward the ship on account of the strong current, or "set," running northward. The strain upon the shot-line increased with every inch of the whip-line exposed to the action of the current, and all this time was actually sawing across the iron-wire rope of which the stay was made. The whip had progressed more than half way to the vessel and the block had lifted clear of the sea when the damaging chafe of the line as it was hastily hauled across the sharp incline of the iron-wire stay, together with the strain caused by the strong current, caused the shot-line to part.

A citizen, John J. Dunton, testifies that at this juncture the whip had

"fouled with something under water," and it is possible that some circumstance of this nature assisted in producing the accident. Had the shot-line been dropped to starboard of the stay by the man aloft, as it should have been, and the handling of it on board been intelligently directed, the result would have been different. This is the first instance in the history of the service that a shot-line has parted after reaching a wreck. The line used was a new one of Italian hemp, braided after the style of the patent sash-cord of the Silver Lake Company. It is always free from turns, however coiled, and very rarely kinks when flying from its faking-box. No shot-line ever used is superior to it. The line was at once French-faked on the beach for another attempt, which was for some time delayed by the strange and inexcusable neglect of the keeper in having but two charges of powder in his flask. The station, where plenty of powder is stored, was four and a half miles away, and recourse was had to Mr. Brock, and a supply of powder was brought from his house with all possible haste. By this means a third shot was fired, the line parting at the ball, which went far to seaward. But one ball remained, the first shot having been hauled ashore, with which the fourth shot was fired with like result. A statement having been published that the line parted in consequence of a spiral wire or other appliance for connecting the line with the shot not having been used, it is proper to remark that after many experiments these methods have been abandoned, and the best results are obtained by attaching the line, after wetting it for a few feet at the end, directly to the projectile. The line rarely breaks when connection is made in this way, but more frequently does so when the devices referred to are employed. In this instance the line having gone safely at the first two shots I can only account for the failure of the other two, by supposing that the powder obtained from Mr. Brock was of a stronger and quicker nature than the slower-burning powder provided for the mortars, and the initial velocity of the ball thus became greater than the line could bear with its increased weight, water-soaked and partially clogged with sand as it was after the second shot.

The only hope of the life-saving men now remained in the possibility of procuring more balls and powder, and a dry line from the station. Horses were unavailable and two men were sent on foot. They obtained a horse to hasten their return, but arrived only when the tragedy was ended. In the mean time, Keeper Chappel put on the Merriman life-saving dress, and attempted to reach the wreck with a line, but greatly fatigued by his march and labor, he was unable to stem the strong current and force his way beyond the breakers, and after two praiseworthy efforts was compelled to abandon the endeavor, exhausted. Will it be believed that a man, provided with a similar dress, stood on the deck of the Metropolis in this trying time, yet made no offer to bring a line ashore, which, properly habited in the dress, with a stout heart and bold effort, he might have done with comparative facility on the incoming seas?

When the hapless people remaining on the wreck realized that no further effort could be made, for their rescue from the fast-crumbling remains of the doomed Metropolis, they accepted their last alternative, and singly and sometimes in groups plunged overboard, trusting their lives to the treacherous waves. The surf, by this time, was running high, and the waters were laden with floating fragments of the wreck, amid which, sorely and in some cases fatally injured, drifting northward, and driven by the rolling breakers shoreward, came the struggling, drowning people, to be received in the welcome arms of their rescuers, who, with precarious foot-hold, strove in their work waist-deep in the inner breakers and undertow. Prominent among these brave and humane

men were Keeper Chappel and his surfmen, Samuel A. Gillett and Piggott Gillikin, together with S. C. Brock, J. J. Dunton, William Jones, N. E. K. Jones, T. J. Poyner, Captain Everton, and John Saunders and others resident in that vicinity. Even a noble Newfoundland dog, owned by Mr. Brock, incited by the example before him, joined in the work and plunging into the surf safely brought to shore a half-drowned man. In a word, all present were engaged either in hauling the people out of the surf or receiving them from others and assisting them to the fires kept burning near the sand-hills.

The labors of the rescuers in the surf were unceasing, but their greatest exertions were required when the vessel finally broke up, toward sunset, and the surf was thick with people and fragments. The rescuers, without exception, were battered and bruised by the wreckage, while extricating the drowning people from the masses of floating rubbish.

The scene may be better imagined than described. It was one of terror and wild confusion, of struggling heroes and perishing victims in the greedy seas, while the air was filled with encouraging shouts and despairing shrieks. In the midst of this last scene, a man, who afterward proved to be Captain Ankers, was seen struggling in the surf, clad in a rubber swimming or life-saving suit. He was helplessly tossed about in the sea, utterly unable to help himself. Observing this, Keeper Chappel went further into the breakers, followed by Surfman Piggott Gillikin and Mr. Brock, and seizing the captain brought him, aided by his companions, safely ashore, much exhausted, and with his rubber dress, from some unexplained cause, nearly filled with water. He was taken to Mr. Brock's house, where he remained kindly cared for until the next morning.

No account was taken of the number thus rescued, but it was thought to be more than a hundred. The medicine-chest was of incalculable service, and several persons were restored from apparent death. The survivors were distributed among the neighboring dwellings, the life-saving stations being too far away to be reached in their exhausted condition. The citizens fed and clothed them to the full extent of their means, and their generous hospitality is worthy of all praise. In this regard the light-house keeper, Mr. Burris, and Messrs. J. J. Dunton, S. C. Brock, Josephus Baum, and T. J. Poyner, deserve particular notice.

It will be seen from the foregoing that the crew of station 4 do not deserve the censure which has been applied to them. Regarding their conduct I found but one sentiment among the people of that neighborhood, as to their faithful and unremitting efforts to rescue the passengers and crew of the Metropolis. The evidence of all the witnesses is to this effect, but I quote from the testimony of the Signal-Service observer, William Davis, whose position afforded probably the best opportunity for hearing a free expression of opinion immediately after the event. He states:

> As near as I can find out the life-saving men did all that human beings could do in trying to save life and care for the living. They ran great risk in hauling people out of the surf, the fragments of the wreck striking them with great force in the rough sea. I was informed by the citizens who were at the wreck, that the life-saving men worked faithfully. I was also informed by the life-saving men that the citizens all worked faithfully in saving lives, carrying those saved to their own dwellings and furnishing clothing for the naked. * * * * The life-saving men deserve much honor and praise for their bravery in risking their own lives to save those about to perish. I will say that there were only two men who spoke against the life-saving service: one was the captain, and another who had charge of the passengers.

Much unfavorable comment has been made on the fact that the wreck was not discovered by the patrol. Under the circumstances this was

impossible. Perry, who had the south patrol from midnight until sunrise that morning, returned to the station at 7 o'clock, and probably passed the place where the wreck occurred about 5 o'clock a. m. If Rogers, the next patrolman south, had left the station immediately upon the return of Perry, and traveled at the rate of three miles per hour, no small task through the soft sand, for it was then nearly high water according to the Coast Survey Tide Tables (6 a. m. for Oregon Inlet; difference at Currituck small), he would have seen the wreck about 8.30 a. m., or about the time she was discovered by Capps and Jones. He could not possibly have carried the news to the station as quickly as it was done by Mr. Brock on horseback, so that really no time would have been gained. When Perry passed the place where the ship afterward struck it was not yet daylight, and the weather was thick and foggy; otherwise, he might have seen the vessel's lights approaching land. If the Metropolis had carried, as I am informed she did not, a small gun or swivel for making sound-signals of distress, and it had been fired two or three times when she struck or as she neared the land, its reports would have been heard at the light-house, and also at the station as the wind was, and there would have been time for the life-saving crew to have reached the wreck before the hour they were notified by Mr. Brock.

The necessity for additional stations on this coast is apparent from the extent of the patrol alone, and when the terrible nature of the coast and its liability to frequent shipwreck are considered, appears extreme. The stations should not average more that four or five miles apart, and even with these there are portions of the coast which it would be perhaps impossible to protect against disastrous results to life, in case of shipwreck upon them. There are such places notably between numbers 2 and 3 where heavy gales from the eastward drive the sea across the low, flat shore, into the sound, and strong westerly gales, following long-continued southerly winds, force the waters of the sound across the same flat shores to the ocean. The water then on the flat would prevent the approach and use of the mortar apparatus at a wreck, and would be too shoal for the passage of boats. These points are of varied extent, being in places from one-fourth by one-half mile north and south by three-fourths of a mile east and west, and in one place three miles north and south. Wrecks occurring at these places during great easterly gales must be beyond human aid from the shore until the waters recede.

The increased number of stations, with some experience to the surfmen, would make the sixth district quite as efficient as the third and fourth districts, where it is noteworthy that in the same storms which wrecked the Huron and the Metropolis in the sixth district, the crews of two vessels were rescued on each occasion by the crews of the stations.

I carefully inspected station 4, and found it fully equipped with every appliance adapted to the nature of the coast, and the apparatus in perfect condition. The surf-boat is in fine order and admirably adapted for service on the coast. The weight is about 750 pounds, and a heavier or self-bailing and self-righting life-boat cannot be used anywhere along the coast except, perhaps, from Oregon or Hatteras Inlet.

The men appear to be familiar with the drill and exercise with boat and apparatus, but the Life-Saving Service having been but recently introduced in this district, they need more experience in actual service at wrecks with the boats, as they are unaccustomed to going off against a very heavy surf. Their experience as surfmen has been gained principally as fishermen going to sea in comparatively moderate weather, in boats, which, compared with those supplied the stations, are clumsy

and frail affairs. Further experience with the life-saving boats and apparatus will also enable them to command such respect from the people who always assemble at a wreck, as to deter the latter from volunteering advice and suggestions to the life-saving men, at present a great obstacle to orderly and methodical operations on this coast, and instead induce them to lend their assistance under the direction of the keeper, whose superior experience and judgment will then be recognized.

The proposed additional stations, with an increase of two surfmen to each, will, in my opinion, amply provide for the needs of the coast, and make the service there as efficient in its operations as in the older districts on Long Island and New Jersey, by reducing the length of the patrols, enabling earlier discovery of wrecks, prompter arrival of boats and apparatus at the same, and the early assemblage of the crews of adjacent stations when signaled for aid. The two additional men will materially relieve the labors of the patrol, besides affording an extra man to care for the station while the crew is engaged at a wreck, and another to remain on the beach to aid the boat in landing, and for other useful duties.

As upon other portions of the coast of the United States, it is difficult to obtain competent men for keepers at the present rates of compensation. It should be sufficiently increased to secure the best men for these positions, and they should be required to reside at the stations the year round.

I examined the fragments of the wreck which littered the beach for two miles above the spot where the steam-chimneys of the boilers alone indicate the place the vessel struck. The fragments are unusually small and her rottenness so apparent that there was but one opinion as to her unseaworthiness among the many persons I met on the ground. I submit herewith two pieces of decayed wood from different parts of the vessel's frame, fair samples of a large portion of the timbers.

I submit herewith the sworn statements of the keeper and crew of station No. 4, together with the affidavits of John J. Dunton, N. E. K. Jones, S. C. Brock, and James E. Capps, who reside in the immediate vicinity of the wreck; also the sworn statements of N. G. Burris, keeper of Currituck light-house, and of William Davis, Signal-Service observer, then at station 4. These were the only prominent persons who appeared to be familiar with the circumstances attending the discovery of the wreck and the subsequent events.

I also submit a brief documentary history of the Metropolis, formerly the Stars and Stripes.

Very respectfully, your obedient servant,

J. H. MERRYMAN,

Captain United States Revenue Marine, Inspector.

Hon. JOHN SHERMAN,

Secretary of the Treasury.

JOHN G. CHAPPELL.

Keeper of station No. 4, Jones Hill, North Carolina; aged 42 years; home 15 miles from station. Have belonged to service since December, 1875, and keeper since March, 1876; succeeded Captain Gale. Occupation, fishing and farming; former in fall, winter, and spring, mostly in the sound, sometimes off shore. Was at station on Thursday, 31st January.

First heard of wreck of the Metropolis about 10 a. m. that day, from Swepson C. Brock, who met the patrol, John Rogers, and came with him to station. Brock was mounted. He said there was a wreck ashore

opposite his house, that she was going to pieces as fast as she could; that men were washing off and coming ashore; said no assistance could be rendered except to drag the people out of the water; also to hurry there. Went to work loading the hand-cart with mortar, three shot, whip-line (large one), breeches-buoy, large tackle, heaving-stick with line, flask of powder, quick-matches, match-rope, and the new shot-line, braided large, and "Merriman dress"; occupied about ten minutes; took medicine-chest, and started with Brock, the hand-cart following, hauled by six men; the distance to wreck about four miles and a half.

With Brock reached wreck about 11.30. Hand-cart arrived about 12 or 12.30. Did not notice the hour; do not carry a time-piece. Before reaching wreck saw four or five bodies on the beach, one a female, Mrs. Harris; did not see the wreck until within half a mile of it; weather was thick; tide about half ebb. The sea had been over the flat near the station that morning. Thought it was a total wreck after seeing the bodies. The wreck was heading on shore, foremast standing, main and mizzen gone; stern and part of port side gone; wreck careened to port; people in starboard side; some in fore-rigging. She was about a hundred yards from the beach.

When hand-cart arrived prepared to throw a line. Placed and loaded the mortar. Thomas Evington, a by-stander, assistant light-keeper, offered to assist, and in attempting to arrange the line-box, moved the frame, and when it was put back in the box the line somehow was fouled. I arranged it afterward.

The first shot carried the line too high and the wind (i. e.) blew it clear over the wreck; otherwise the line would have fallen on the wreck. Hauled in the shot-line assisted by the three light-keepers; faked it while the mortar was loaded again. Depressed the gun (mortar) and the second shot lodged the line on the port yard-arm—fore-topsail yard. The people soon got the line; the whip-line was bent to the shot-line, and the people began hauling; the current was strong to the northward. The shot-line was hauled on board across the fore stay, which was of wire; those hauling stood on the starboard side, and the bight of the line trending to the northward the strain was great. The block of the whip got about half way to the wreck when the shot-line parted, having been chafed in two by hauling across the fore-stay, the nip being very short; hauled the whip ashore. The shot-line that came back with the whip was 158 yards long (measured since); a great deal of the shot-line had been hauled on board before they could get a steady pull on it.

Faked the shot-line as quickly as possible, and fired again, but the shot-line parted at the shot. Another shot was fired, line parting as before. Had hauled one ball in—the first one fired. Had expended all the powder in the flask. Sent to the station for another line, three shot, and the powder-tank. Tried, in vain, to get horses. The men got one and a cart near the station. When they arrived at the wreck, with the lines, &c., it was too late.

Then put on the rubber suit and made two attempts to reach the wreck; but could not get beyond the breakers. Have practiced in it before. The sea was very rough; could not get through it in the Merriman dress. The wreck was breaking up all the while, and after the failure to reach them in the Merriman suit, the people began to jump overboard. As they came in with the breakers the station-men and several persons went in after them and brought them ashore. Don't know how many were thus saved; perhaps a hundred.

Every one who came inside the breakers was saved, except a few who died from exhaustion after getting them ashore. The station-men,

and some others, went into the surf after the people, and bringing them out they were taken by the by-standers to the fires, of which several had been built and were kept burning on the beach.

Saw Captain Ankers coming in, with a rubber suit (Merriman's); appeared helpless. Went in with Mr. Brock, up to the waist, to assist the captain, and brought him ashore. His rubber suit was full of water. Could not have reached the shore without assistance. Five of the station-men, including keeper, were badly bruised with wreckage striking them while in the surf. Were about three hours thus rescuing the people; every one got thoroughly wet. The weather was not very cold. All might have been saved if the station had known of the wreck earlier; or if a team had been at hand, could have saved all who were on the wreck when it was first reached.

William Perry had the south patrol that morning; left the station at 12 midnight, and returned about 7 a. m. The beat can be covered in five hours, at a steady pace. In bad weather, against a gale up or down the beat, it will take longer, and high water makes harder walking. The patrol is ordered to remain out from midnight to sunrise. The beat is six miles south, about eight miles north. If the boat had been there when the wreck was first reached, it could have gone off safely to the ship. An hour later it could not, as the sea grew higher.

JOHN G. CHAPPELL.

Sworn and subscribed to before me this 4th day of February, 1878.

J. H. MERRYMAN,
Captain United States Revenue Marine, Inspector.

WILLIAM PERRY.

Surfman; fisherman (blue-fish). Age 24. Reside at Kittyhawk Banks. Have served since 5th March, 1876. Was on south patrol on the morning of 31st January. Went to the end of the beat. Was there about 3 a. m. or 3.30 a. m. Weather thick and rainy. The water was running over the beach, and it was bad traveling; had to rest occasionally. Saw no vessels nor lights. Did not meet patrol from station 5. Have met him; met him the night before. Returned to station at 7 a. m. It was still thick and rainy. Afterward, assisted the men with the hand-cart, and ran into the sea after the people several times. Have heard Keeper Chappell's statement read, and believe it to be true as far as I know. Was not there when the keeper helped the captain ashore.

WILLIAM PERRY.

Sworn and subscribed to before me this 4th day of February, 1878.

J. H. MERRYMAN,
Captain United States Revenue Marine.

PIGGOTT GILLIKIN.

Surfman; seaman for thirty years, from cook to master. Fifty years of age. Have been at station since December last. Was on patrol first part of night January 30, north; came in at 12. Assisted in hauling hand-cart to wreck of Metropolis. Left station about 10 o'clock. Hauling was bad; sand was wet and heavy; could not have hauled it with six men. A Mr. Dunton overtook us about one and a half miles from station, in horse-cart; got him to help. All were much exhausted. Don't know what time the wreck was reached. The mortar was fired as described by the keeper. The line was cut by the fore-stay; could not see how many were hauling on it. Saw a man get the line from the port fore-topsail yard-arm. He was no seaman, for he went out and

laid in astride the yard. The line was not dipped under the stays; was hauled across the port side of the stay by men standing on starboard side of hurricane-deck; a very strong current running north two and a half miles per hour. The tally-board went off with the whip-line. The line was badly managed by those on board the wreck. Saw the captain coming on shore in the Merriman dress, sometimes head up, then feet up; on his face, and sometimes on his back. Saw keeper go in to help him; followed the keeper, also Mr. Brock. Keeper caught him first, then I got his right hand, and Mr. Brock got hold of his right shoulder. The captain appeared to be perfectly exhausted. Kept no account of the people we helped; had no time; all worked as hard at it as possible. Had been there in time could have saved every soul. As it was, the station-men and citizens saved nearly all who came inside the breakers after they got there, or until it was all over.

PIGGOTT GILLIKIN.

Sworn and subscribed to before me this 4th day of February, 1878.

J. H. MERRYMAN,
Captain United States Revenue Marine, Inspector.

The undersigned, surfman of station No. 4, sixth district, have heard the foregoing read, and hereby testify to its truth to the best of our knowledge and belief.

his
JOHN + ROGERS.
mark.
his
JAMES + S. ROGERS.
mark.
SAMUEL A. GILLETT.
NAT. GRAY.

Sworn and subscribed to before me this 4th day of February, 1878.

J. H. MERRYMAN,
Captain United States Revenue Marine, Inspector.

WILLIAM DAVIS.

Received news of the wrecked Metropolis by messenger on horseback, at 7.15 p. m., on Thursday, 31st of January, 1878. I took instrument, paper, signal-flag, and necessary tools for opening telegraph-station as soon as possible upon arriving at scene of wreck. I started at 7.30, and traveled on horseback 15 miles, leaving my horse and going on foot remainder of trip, which was 4 miles. The reason I went on foot was that the horse was very tired, and I not being used to horseback riding, thought I could travel faster on foot. Arrived at scene of wreck at 3.20 a. m. on Friday morning, cutting the wire and opening communication at 7.30. Upon arriving at scene found two life-saving men taking care of the living, and doing all that was in their power to keep up a fire, and keep those comfortable that were living, by medical aid, &c. At daylight I went up the beach and witnessed the scene, and as near as I can find out the life-saving men did all that human beings could do in their operations in trying to save life, and to care for the living, and burying the dead.

The life-saving men run great risks of their lives, in trying to haul those out of the surf, by fragments of the wrecked steamer striking them with great force by the rough sea. I was informed by the citizens that were at the wreck that they said the life-saving men had worked

faithfully in rescuing those who were struggling in the water, and caring for those who were safe on land, and burying the dead. I was also informed by the life-saving men that the citizens had all worked faithfully in saving the lives and carrying them to their dwelling-houses and furnishing clothing for the naked. In closing I will say that the Life-Saving Service deserves much honor and praise in being so brave in running the risk of their own lives to save the lives of those who were about to perish. I will say that there were only two men who spoke against the Life-Saving Service; one was the captain, and one who had charge of the passengers, and I think the latter said more than he ought to have said; in fact both spoke very hard of the service, not knowing what the duty of the service were required to do.

WILLIAM DAVIS.

Sworn and subscribed to before me this 4th day of February, 1878.

J. H. MERRYMAN,
Inspector.

N. E. K. JONES, of Currituck Beach, North Carolinia, being duly sworn, deposes and says:

After a blow, I generally make it a custom to go out on the beach to see if any vessel or stranded property has come ashore. I, in company with James E. Capps, went out on the beach Thursday morning between 8 and 9 o'clock. While on our way we saw the mast of a vessel. Capps said, "Mr. Jones, yonder is a vessel ashore." I noticed it, and we hurried down as fast as we could. It was quite foggy, and at times the vessel was obscured by the mist, which caused us several different times to think she had gone to pieces. When we got near the vessel, we couldn't distinguish whether there was any one aboard or not. When we arrived abreast of her, we discovered men, and they cheered us. Knowing I had no team to go to the station, I hardly knew what to do. I told Capps to go up to Mr. Brock's (the nearest neighbor) and get his horse and go to station four and notify them of the wreck. Capps started off on a run, and soon after he left I discovered that a man had jumped overboard, and in watching for him saw several others in the water. I also saw one or two men further up the beach to the northward among the *débris*, whom I afterward found to be some who had got ashore in one of the ship's boats. The vessel was lying with head west-southwest, and about 150 yards from the beach. She careened a little to the southward, and there was a heavy surf on. She had one of her square sails set, one mast standing, smoke-stack gone.

I ran down to the surf, and as a man came in, I pulled him out, and placed him out of reach of the water. I then pulled out another. All had on life-preservers. After I had pulled out about six or eight, Mr. Brock came down on his horse on his way to the station for help. I ran up and asked him if he had any matches, as the men were nearly frozen, and I wanted to build them a fire. He had none and went off on a run toward the station with his horse. I continued pulling men out as fast as I could. It was with difficulty that I could free myself from one of the men I pulled out; he held on to me after I got him out of the water, but I had to leave him and attend to others. A little further up the beach saw a man on his knees by a telegraph-pole. One of the survivors and myself raised him up, he having been bruised by the drift-stuff, as we afterward learned. A number of the survivors asked me to take him to my house, which I did, several others accompanying me.

While on my way home, Mr. Brock overtook me, as he returned from

the station, and said Captain Chappell and crew were coming right down with the apparatus. I came home with the men, and left them in care of my wife, and returned to the beach to look out for others. When I returned the life-saving crew were there, together with the keepers of Currituck light house; also John Dunton, Bill Jones, Mr. Brock, and others. The life-saving crew were getting things in readiness for action. The mortar was fired, and at first shot the ball was thrown over the end of one of the spars (don't know the name of it). The crew of the vessel cheered and we returned it. Soon we saw one of the crew of the vessel going out on the spar after the line. He seemed to have great difficulty in getting it and getting back to the mast. The ship's crew then pulled on the line. Some on the beach said we ought to go up the beach with one part of the whip, and others said we ought to go down with it, as the current was running strong to the northward. We walked down the beach to the southward against the current for some distance. There seemed to be a great deal of strain on the rope (whip). The people on board succeeded in raising the block clear of the water, when the shot-line parted, and that end of the whip went adrift.

We hauled it ashore as quick as we could, while the life-saving crew got ready for another shot. The mortar was fired again, and the line parted near the ball without taking out any of the line. They then got ready for another shot, but found they had no powder. Mr. Brock furnished some, and, I think, they fired again, but can't remember what the result was.

Some one asked whether the vessel's life-boat (which had come ashore in the morning) couldn't be used to take the people off. Some said it was too rough to make the attempt. The crew of the vessel then seemed to get impatient and began to jump over again. By this time—twelve or one o'clock—a crowd began to accumulate on the beach, some coming from the mainland. Some one asked in my presence why the life-saving crew didn't go after what they wanted to render further assistance with the apparatus. I suppose they meant the surf-boat. Then the life-saving crew, with the rest of us, dropped the apparatus and went to work to save the people as they washed up. I think we saved in all at least one hundred.

The tide then began to make and the vessel began to break up pretty fast, and about an hour before sunset the mast fell and the sail with it. Directly after this I saw fifty or sixty men clustered together on the northward gunwale. Just after the mast fell I looked toward the wreck and found the vessel was entirely gone and the people with it. I remained, with others, on the beach until all that could be saved were saved. The greater number saved had on cork jackets, as had also those who perished.

It was found that quite a number of the bodies were badly bruised, caused probably by coming in contact with pieces of wreck. The vessel was evidently an old one, as shown by the small and rotten pieces that came ashore.

There being no more lives to save, I went on up the beach to look out for wrecked stuff, the fragments of which were strewn up the beach as far as Whale's Head, about two miles. I returned home, arriving about dark. Found the gentleman, Captain Harrison, whom I had left at my house that morning, much better. He made some inquiries in regard to his wife, whom he supposed was drowned. I told him there was one lady saved and two missing. He asked me to describe them, and I did so. He said the drowned one was his wife, and requested me to go down with him after supper to the body, which I did. It proved to be

his wife. He returned home with me and remained all night. While we were on the beach he noticed one of his trunks—also those of Mrs. Myers—had been broken open. Captain Harrison told me that his trunks had been broken open by some of the ship's company, as he had seen one of them wearing a suit of his own clothes.

This is all I know of the wreck of the steamer Metropolis.

N. E. K. JONES.

Personally appeared before me and testified to the aforegoing this 4th of February, 1878.

WALTER WALTON,
Assistant Inspector and Acting Superintendent.

S. C. Brock, of Hobbs Woods, and residing on the sound shore, Currituck Beach, North Carolina, being duly sworn, deposes and says:

At about eight o'clock on the morning of January 31, I was on the marsh near my house and heard at short intervals peculiar cries, like the sound of many human voices, and stopped to listen. The wind was from the eastward, thick weather, and the sounds seemed to proceed from the direction of the ocean. Just at this time I was called by James E. Capps, a boy who was in one of the upper windows of my house. I went with all speed to the house. I found my horse ready to be saddled. The boy said he had been to the beach and that there was a steamer ashore just abreast of my house, and that he thought there were women aboard. I mounted my horse and galloped to the beach abreast the wreck, waved my hat to the people on board to let them know assistance would be rendered, and galloped up the beach to give information to station No. 4.

I noticed that the steamer was lying about 100 yards from the shore, (it being then low water) and heading about west-southwest. She was square-rigged forward, fore-and-aft rigged aft, and her mainmast had fallen, also her smoke-stack. There were many people on board, a great number of them with cork jackets on. They were crying and screaming for help. The sea was very heavy; about as heavy as we usually have it here, and was breaking over the vessel, which had careened over slightly toward the sea to the southeast.

On my way to station 4, about one-half mile to northward of wreck I noticed a metallic boat on the beach all burst to pieces. I supposed it was one of the steamer's boats. I had got within about one-quarter of a mile from the station when I met one of the patrol of station 4 coming south, I asked him how far it was to the station. He said about a quarter of a mile. I told him there was a vessel ashore just abreast my house and rode on toward the station, the man following. I arrived at station about half past eight, as near as I can judge; did not see Keeper Chappell, but told his crew there was a vessel ashore just abreast my house, and they immediately commenced preparations.

Just then Captain Chappell came up from the beach, and I reiterated my information. He told the boys to get ready as soon as possible. He asked me if I thought he could get his boat down there in time. I told him I did not, the distance being great and the vessel fast breaking up. He then put the mortar apparatus in the hand-cart, and taking the medicine-chest, he and I started for the wreck, leaving the crew to follow with apparatus.

I soon after relieved the keeper of the medicine-chest and took it on my horse until within a mile of the wreck, when the keeper took the chest and told me to ride on quickly and see if I could relieve or assist

those coming off the wreck. I went on with all speed, and on my arrival found about twenty people ashore alive, and sent a number to my house to be cared for; part went to N. E. K. Jones's. They all had on cork jackets when they came ashore. Saw no persons washing ashore at this time. I took off my hat and waved to those on board to let them know that assistance was coming from station 4. I then went to my house, as my wife was sick, where I found a number of the survivors. Others had been there, and having warmed themselves, had gone back to the beach to render assistance.

I immediately went back to the beach ready to lend a hand, and commenced making fires, as it was chilly, and numbers were only partially dressed. About half past twelve o'clock the life-saving crew arrived with the mortar apparatus. By this time the wind had shifted to southwest, and the mortar apparatus was put in position ready for firing. The mortar was aimed to windward, as I supposed, to allow for drift. The first shot went over and to windward of the foremast, but the bight of line drifted to leeward, and the mainmast being gone there was nothing to fetch up the bight of the line and it passed over the stern of the vessel and overboard.

The line was then hauled in with shot attached by the life-saving crew, the mortar reloaded and fired again. The second shot was fired with apparent success, passing over the port fore-topsail yard-arm, the topsail being set and the jib-stay. Saw a man go aloft to get the line, whom I afterward learned was the second mate; passed the line down to the crew on deck, who began pulling on it. They had got the tail-block, with tally-board attached, within about 150 feet of the side of the vessel when the line parted, there being a heavy current setting to the northward, and bringing, according to my judgment, a heavy strain upon the whip. The shot-line, minus the ball, was hauled in a second time by the crew of station 4, together with the whip and tail-block.

Everything was got ready for a third shot when the keeper found he was out of powder. I immediately sent to my house for powder. The mortar was then loaded for a third time and fired, when the line parted at once near the ball. The mortar was loaded with third and last ball, fired, and cut the line at the ball as before without taking any of the line.

Just at this moment the first officer of the stranded vessel came up and asked the crowd if there was any possible way of getting information to the adjacent station south; also to a telegraph-operator. Nothing was said for awhile. I noticed this and said, "Yes, there is a way, that I had a horse and man whom I would send on horseback to Mr. Poyner, who would forward the telegram if he could; if not, I would see that the message was sent on. I sent the officer's telegram to Mr. Poyner, who sent word back that he would send the telegram on at once. This was about three in the afternoon. There was no one washing ashore at this time; they seemed to be waiting or holding on, evidently expecting assistance. So far as I know there was no attempt made by the people on board to send a line ashore by a cask or spar, but they hallooed and made motion to the effect that we were to look out for a line, and I learned afterward from one of the survivors that a man did jump overboard with a line in his teeth, intending to swim ashore with it, but they did not pay out the line fast enough to him, and he was compelled to relinquish his hold, and he swam ashore without it.

Keeper Chappell asked me if I could send a man back to the station for more balls. I told him I could not as my horse had gone south with

a telegram. Chappell then said he didn't know what he should do. So far as I know there was no horse to be had in the vicinity. No immediate assistance being rendered the people began to jump overboard on doors and other fragments of joiner-work from the vessel. Then the station crew assisted by N. E. K. Jones, James E. Capps, and myself waded into the surf and rescued the drowning men. My dog (a large Newfoundland) also went in and dragged one man out.

Shortly afterward a number of citizens arrived from the mainland and elsewhere, among whom were Thomas J. Poyner, Captain Everton, wreck-commissioner, John Saunders, Alonzo Williams, Buchanan Williams, Thomas Litchfield, Sanford Dunton, John Dunton, and others. All united with us in saving life. Nearly if not quite all of those saved had on cork jackets. There was a strong current running to the northward carrying everything in that direction. There was one man swimming ashore who had on a cork jacket. He doubtless would have been saved, but a heavy sea breaking threw a lot of drift-stuff over him and he drowned. The beach was strewn with fragments of the wreck for a distance of at least two miles. About this time the captain of the stranded vessel came in toward the shore. Keeper Chappell and myself seized hold of him and brought him ashore. He had on a rubber suit (Merriman's.)

Shortly after this (just before sunset) the foremast fell, covering a number of people under the sail and killing and crippling a great many and knocking them overboard. A few minutes after this the vessel broke up and disappeared almost entirely. There was a great struggle now to save life, as everybody who had remained on the vessel up to this time was overboard. We all pitched in and did our best. Don't know how many were saved in all, but think at least one hundred. At about sunset I left the beach; I was lame, having been struck by a drifting door while endeavoring to save life. I took the captain of the steamer to my house, where the purser and twelve others (survivors) were being properly taken care of. About seven in the evening a surfman from station 5 came up and asked me if I could take care of a woman, one of the survivors. I told him yes, if they could get her here. I gave them my wife's cloak. Mr. Josephus Baum's cart being on the beach, she was taken to his house and properly taken care of.

When I left the beach saw a great number of survivors round the fires. There were a great many more people there than I could take care of. I remained home all night, and next morning (Friday, 1st) went back to the beach, saw a number of the shipwrecked people, who said they had had nothing to eat for two days. I sent a number of them to my house at different times throughout the day for food and shelter. There was one man lying down on a bench by a fire suffering very much, having been injured internally by the wreck. I told Keeper Chappell of this, and he took his medicine-chest, went immediately to the man, gave him some brandy, and applied mustard-plasters. Josephus Baum soon came in a cart, took the man to his house, and properly cared for him. John Baker and others contributed clothing for the man.

The captain of the steamer directed me to employ hands to gather up the property and take care of it, and bury the bodies. We buried about twenty-three; all those whose names could be ascertained I wrote with a pencil or red chalk on the head-boards; and they are so buried as to be quickly and easily identified by myself. Jimmy Williams, Joshua Beaseley, Benjamin S. Harrison, and two others (names I don't remem-

ber) assisted in burying the dead. I saw no jewelry or trinkets of any kind on any of the bodies.

Joshua Beaseley told me that while they were burying the bodies one of the survivors came up and said he was searching for his chum; that he had $13 or $15 on him, and he wanted to get it and take it to his wife. He found his chum, knew him, and found the money, and took it from him in Beaseley's presence. We got through burying the bodies just before night. It was said there was a great deal of provision aboard, but I saw very little of it. What I did see was a few barrels of hard bread.

On Friday night I took care of sixteen persons, among whom were George A. Yoke, Thomas Cogan, B. J. White, R. Clark, and A. W. Newton.

This is all I know of the wreck of the steamer Metropolis.

S. C. BROCK.

Personally appeared before me and testified to the foregoing this 4th of February, 1878.

WALTER WALTON,
Assistant Inspector and Acting Superintendent.

JOHN J. DUNTON, being duly sworn, deposes and says:

I left my house, "Light-House Club," Currituck Beach, about nine o'clock, going down the beach south, and about 9.30 a. m. meeting survivors from the Metropolis coming to the house. Turning my horse around, riding back as soon as possible, finding some of the survivors at my house when I reached there, I gave them all the clothes I had except one suit, and putting a man on my horse sent him to life-saving station 4 for assistance; but Mr. Brock being ahead of me my horse turned back home. I hitched him to the cart, and started to the wreck to render assistance, together with the first mate of the stranded vessel. I rode about one-eighth mile down the beach, when I overtook the life-saving crew, station 4, with their hand-cart, shot-line, mortar, and whip-line. They were worn down, it being a bad beach for men to travel, and asked me for assistance. I hitched onto the cart and was glad to do so. I took them down to the wreck. We arrived at the wreck about twelve o'clock. The mortar was immediately got into operation. The first shot parted the line. The second shot parted the line. The third shot went over the fore-topsail-yard, and the line caught on yard-arm. Second mate got the line, overhauled it down to the people on deck on the starboard side. The line was hauled across the fore-stay. The whip got half way to the ship when it fouled with something under water, and the shot-line broke. The fourth shot was then fired and parted line. There was a strong current running at the time, and too many men pulling at the shot-line. Two of the life-saving crew started immediately for the station for both powder and balls. Soon after that the people began to jump overboard and leave the ship. We all, citizens and life-saving crew, pulled the drowning men out of the surf. Surfman Gillett, station 4, with a line tied around his body, and myself hold of the line, went in and pulled all out we could. A little before sunset the foremast fell, and the ship broke up completely. By dusk all that could be saved were rescued. I think we saved at least one hundred and twenty-five. I then returned home, found my house crowded with the survivors, about seventy in all, whom I fed and took

care of to the best of my ability and means. They remained at my house until Saturday noon, when they left in the steamer Cygnet for Norfolk. I would like to state that on Friday evening, the day after the wreck, I was on my way home, coming up the beach I saw a man (one of the survivors) break open the surgeon's case of instruments. The first officer rebuked the man for it. This is all I know in relation to the wreck of the steamer Metropolis.

JOHN J. DUNTON.

Personally appeared before me and testified to the foregoing this 4th day of February, 1878.

WALTER WALTON,
Assistant Inspector and Acting Superintendent.

Mr. N. G. BURRIS, keeper of Currituck light-house, North Carolina, being duly sworn, deposes and says:

About 10 o'clock in the forenoon of Thursday, January 31, I was informed by a messenger from the Light-House Club that there was a vessel ashore. This was, I think, before information was received by life-saving station 4. The weather was foggy. I immediately started down the beach and on my way was overtaken by the crew of life-saving station 4, with mortar apparatus. I was accompanied by both the assistant light-keepers. We had got down some distance when we saw the body of a man washed up on the beach. We went along a little further and we saw the body of a woman also on the beach. They were insensible, but nevertheless we endeavored to resuscitate them, but without success. We went on a little farther, and we saw through the mist the wreck. Saw only one mast, smoke-stack gone, and the greater portion of the vessel broken up, and the deck covered with people. In a short time the mortar apparatus was brought into requisition. At the first fire the ball missed the wreck. The second shot, however, the line fell across the jib-stay, well up. The crew of the vessel began hauling on the shot-line; they had got the block within 75 yards of the vessel when the line parted. Then preparations were made for a third shot, the mortar fired and the line parted. They again got the mortar ready and the fourth shot fired, the line parted as before. During the firing I was busy faking the line down on the beach, and didn't know exactly what was going on on the beach. The people on board then saw there was nothing being done for their help, and began jumping overboard. Then we all endeavored to save life to the best advantage; three men I noticed particularly who by their extraordinary and prolonged exertions in rescuing life, seemed to distinguish themselves. Their names were John J. Dunton, and Surfmen Gillett and Gillikin, of life-saving station 4. Mr. Brock, William Jones, with many other citizens also, were particularly noticeable in their eagerness and willingness to save life. About four o'clock in the afternoon, I being completely worn out and exhausted, started for home. When near the light-house I turned and looked back and saw the mast had fallen, and no sign of the vessel remained. I took one of the survivors home with me, and shortly after my arrival a great many more of the survivors in an exhausted and destitute condition flocked to the house. I furnished food and shelter for sixty-one persons that night, and for about seventy-six for breakfast and dinner; also sheltered them that night and gave them a breakfast the following morning (Saturday). They left at noon for the steamer

to Norfolk, Va. This is all I know in relation to the wreck of the steamer Metropolis.

N. G. BURRIS.

Personally appeared before me and testified to the foregoing, this 4th day of February, 1878.

WALTER WALTON,
Assistant Inspector and Acting Superintendent.

JAMES E. CAPPS, gunner and trapper, of Currituck Beach, North Carolina, being duly sworn, deposes and says:

About eight o'clock in the morning of Thursday, January 31, myself and N. E. Jones were walking across the beach toward the surf when I looked in a northerly direction and saw the mast of the vessel close in. The weather was foggy. I said to Jones, "Yonder is a vessel's mast," and we hurried toward it as quickly as possible. At first Mr. Jones said it must be a vessel abandoned, and that some vessel had taken the people off. As we got closer we could see people on board moving about; they waved their hats to us and and hallooed for help. Mr. Jones then told me to go and inform Mr. Brock, so that he could go and let the life-saving crew at station No. 4 know it. I hurried over to the sound shore and told Mr. Brock, who mounted his horse and rode at full speed north toward the station. I ran back to the beach to help to save the people struggling in the water. The vessel was lying in about a northeast and southwest direction and was already much torn up; the sea was breaking all over her; one mast was standing with sail set on it, and the smoke-stack was gone. At this time only a few men (natives) were on the beach; don't remember their names. We saved the people by taking hold of hands and wading into the surf. About nine o'clock Mr. Brock returned from the station, and afterwards assisted in saving life. At about ten or eleven o'clock in the forenoon the mortar apparatus from station 4 arrived. I was not immediately present when the mortar was first fired, being a little way up the beach. The first shot, I think, did not reach the vessel, but the second shot landed the line across the upper rigging. Saw one of the crew go aloft to get the line, which was then seized hold of by the crew below. Don't know whether they got the whip on board or not; think they did not, for the mortar was fired again with some powder which I brought from Mr. Brock's. I can't state how the apparatus worked because I went up the beach a short distance to see if there were any more people coming ashore. I went north because the current was running strong in that direction.

After the mortar apparatus failed the people began jumping overboard and trying to get on floating pieces of timber. The men on the beach all turned in and helped the strugglers ashore. I didn't notice when the mast fell, as I was busy hauling the people out of the water. I worked, with others, until sunset; by that time the vessel had all broken up, and those that could be seen alive were saved. I think we rescued over 100. I noticed about 10 or 15 dead bodies, some of whom had on cork jackets, but were bruised. I left the beach about dark and went home to Mr. Jones's; saw Mr. Harrison, one of the survivors, there, who asked me and Jones to go down to the beach with him to look for the body of his wife. We found her laid out properly and covered up. We then returned back to the house. The next morning, Friday, 1st instant, Mr. Jones and I went to the beach near the scene of the wreck; saw the telegraph-operator from Kittyhawk at work. At his request I waited on him, and carried his meals. The operator was working out-

doors. I saw a number of natives on the beach; don't remember their names. This is all I know in relation to the wreck of the steamer Metropolis.

his
JAMES E. + KAPPS.
mark.

Sworn and subscribed to before me this 4th day of February, 1878.

WALTER WALTON,
Assistant Inspector and Acting Superintendent Sixth Life-Saving District.

Abstract of the documentary history of the steamship Metropolis, formerly the Stars and Stripes.

AS "STARS AND STRIPES."

First register (temporary) issued New York, May 22, 1861; built at Mystic, Conn., by Mallory; length, 147 feet; beam, 34 feet; depth, 9 feet; $407\frac{75}{95}$ tons, old measurement. Register surrendered July 30, 1861. Sold to United States.

Second register (permanent) issued Philadelphia, September 18, 1865. Purchased of the United States. No evidence produced of time or place of building. Remeasured and register issued by direction of Secretary of the Treasury, per letter of September 1, 1865. Length, 142.9 feet; beam, 35 feet; depth, 16 feet; tons, 484, new measurement.

There were several changes of papers after this register until May 10, 1871, when an enrollment was issued at New York. Owners: John Hegeman, jr., Benjamin P. Lunt, and George D. Lunt; captain, Jere Lunt, all of New York. Surrendered at New York July 20, 1871. Cause of surrender stated, "vessel broken up."

AS THE "METROPOLIS."

First register (temporary) issued at Newburyport, Mass., August 28, 1871; not stated whether built or rebuilt. Owners: George D. Lunt, Benjamin P. Lunt, and John Hegeman, jr., copartners in $\frac{3}{8}$; George D. Lunt $\frac{1}{8}$ and C. W. Copeland $\frac{1}{8}$, of New York, and M. H. Simpson $\frac{3}{8}$, of Boston; captain, Jere Lunt. Length, 198.6 feet; beam, 34.2 feet; depth, 16 feet; tonnage, 879 tons. Purports to have been issued "on master carpenter's certificate." Register indorsed in pencil, "Not to be surrendered until master carpenter's certificate is produced."

The master carpenter's certificate was never produced, but the temporary register was surrendered at New York September 29, 1871, and a permanent one issued upon the nondescript oath of Benjamin P. Lunt, George D. Lunt, and John Hegeman, jr., that the vessel was built for them in August, 1871, at Newburyport.

45TH CONGRESS, } HOUSE OF REPRESENTATIVES. { EX. DOC.
2d Session. } { No. 59.

VETO OF THE SILVER BILL.

MESSAGE

FROM THE

PRESIDENT OF THE UNITED STATES,

ASSIGNING

Reasons for withholding his approval of the bill (H. R. 1093) entitled "An act to authorize the coinage of the standard silver dollar, and to restore its legal-tender character."

FEBRUARY 28, 1878.—Ordered to be printed.

To the House of Representatives:

After a very careful consideration of House bill No. 1093, entitled "An act to authorize the coinage of the standard silver dollar, and to restore its legal-tender character," I feel compelled to return it to the House of Representatives, in which it originated, with my objections to its passage.

Holding the opinion which I expressed in my annual message, "that neither the interests of the government nor of the people of the United States would be promoted by disparaging silver as one of the two precious metals which furnish the coinage of the world; and that legislation which looks to maintaining the volume of intrinsic money to as full a measure of both metals as their relative commercial values will permit, would be neither unjust nor inexpedient"; it has been my earnest desire to concur with Congress in the adoption of such measures to increase the silver coinage of the country as would not impair the obligation of contracts either public or private, nor injuriously affect the public credit. It is only upon the conviction that this bill does not meet these essential requirements that I feel it my duty to withhold from it my approval.

My present official duty as to this bill permits only an attention to the specific objections to its passage, which seem to me so important as to justify me in asking, from the wisdom and duty of Congress, that further consideration of the bill for which the Constitution has, in such cases, provided.

The bill provides for the coinage of silver dollars of the weight of 412½ grains each, of standard silver, to be a legal tender at their nominal value for all debts and dues, public and private, except where otherwise expressly stipulated in the contract. It is well known that the market value of that number of grains of standard silver during the

past year has been from ninety to ninety-two cents as compared with the standard gold dollar. Thus the silver dollar authorized by this b l is worth eight to ten per cent. less than it purports to be worth, and i made a legal tender for debts contracted when the law did not recognize such coins as lawful money.

The right to pay duties in silver, or in certificates for silver deposits, will, when they are issued in sufficient amount to circulate, put an end to the receipt of revenue in gold, and thus compel the payment of silver for both the principal and interest of the public debt. $1,143,493,400 of the bonded debt, now outstanding, was issued prior to February, 1873, when the silver dollar was unknown in circulation in this country, and was only a convenient form of silver bullion for exportation. $583,440,350 of the funded debt has been issued since February, 1873, when gold alone was the coin for which the bonds were sold, and gold alone was the coin in which both parties to the contract understood that the bonds would be paid. These bonds entered into the markets of the world. They were paid for in gold when silver had greatly depreciated, and when no one would have bought them if it had been understood that they would be paid in silver. The sum of $225,000,000 of these bonds has been sold during my administration for gold coin, and the United States received the benefit of these sales by a reduction of the rate of interest to 4 per cent. During the progress of these sales a doubt was suggested as to the coin in which payment of these bonds would be made. The public announcement was thereupon authorized that it was "not to be anticipated that any future legislation of Congress, or any action of any department of the government would sanction or tolerate the redemption of the principal of these bonds, or the payment of the interest thereon, in coin of less value than the coin authorized by law at the time of the issue of the bonds, being the coin exacted by the government in exchange for the same." In view of these facts, it will be justly regarded as a grave breach of the public faith to undertake to pay these bonds, principal or interest, in silver coin worth in the market less than the coin received for them.

It is said that the silver dollar made a legal tender by this bill, will, under its operation, be equivalent in value to the gold dollar. Many supporters of the bill believe this, and would not justify an attempt to pay debts, either public or private, in coin of inferior value to the money of the world. The capital defect of the bill is that it contains no provision protecting from its operation pre-existing debts in case the coinage which it creates shall continue to be of less value than that which was the sole legal tender when they were contracted. If it is now proposed, for the purpose of taking advantage of the depreciation of silver in the payment of debts, to coin and make a legal tender a silver dollar of less commercial value than any dollar whether of gold or paper which is now lawful money in this country, such measure, it will hardly be questioned, will, in the judgment of mankind, be an act of bad faith. As to all debts heretofore contracted, the silver dollar should be made a legal tender only at its market value. The standard of value should not be changed without the consent of both parties to the contract. National promises should be kept with unflinching fidelity. There is no power to compel a nation to pay its just debts. Its credit depends on its honor. The nation owes what it has led or allowed its creditors to expect. I cannot approve a bill which, in my judgment, authorizes the violation of sacred obligations. The obligation of the public faith transcends all questions of profit or public advantage. Its unquestionable maintenance is the dictate as well of the highest expediency, as of

the most necessary duty, and should ever be carefully guarded by the Executive, by Congress, and by the people.

It is my firm conviction that if the country is to be benefited by a silver coinage it can be done only by the issue of silver dollars of full value, which will defraud no man. A currency worth less than it purports to be worth, will in the end defraud not only creditors, but all who are engaged in legitimate business, and none more surely than those who are dependent on their daily labor for their daily bread.

R. B. HAYES.

EXECUTIVE MANSION, *February* 28, 1878.

45TH CONGRESS, } HOUSE OF REPRESENTATIVES. { Ex. Doc.
2d Session. } { No. 60.

NORFOLK HARBOR AND CERTAIN RIVERS IN VIRGINIA.

LETTER

FROM

THE SECRETARY OF WAR,

TRANSMITTING

Reports of engineer upon the improvement of Norfolk Harbor, Hampton River, Pagan Creek, and the Chickahominy and Blackwater Rivers in Virginia.

MARCH 4, 1878.—Referred to the Committee on Commerce and ordered to be printed.

WAR DEPARTMENT,
Washington City, March 1, 1878.

The Secretary of War has the honor to transmit to the House of Representatives, in compliance with the resolution of the House of the 25th ultimo, report of the Chief of Engineers submitting copy of reports relative to the examination and improvement of Norfolk Harbor, Hampton River, Pagan Creek, Chickahominy River, and Blackwater River in Virginia.

GEO. W. MCCRARY,
Secretary of War.

The SPEAKER *of the House of Representatives.*

OFFICE OF THE CHIEF OF ENGINEERS,
Washington, D. C., February 28, 1878.

SIR: I have respectfully to return herewith the resolution of the House of Representatives of February 25, 1878—

That the Secretary of War be, and he is hereby, requested to transmit to this House, at his earliest convenience, so much of the report of the Chief Engineer communicated to the Forty-fourth Congress, bearing date October 18, 1875, as relates to the examination and improvement of the harbor of Norfolk, Hampton River, Pagan Creek, Chickahominy River, and Blackwater River in Virginia, together with such other recommendations and other papers relating thereto as he may deem proper.

and, in compliance with its requirements, to submit the accompanying copy of Appendix W of the report of the Chief of Engineers for the year 1875, which contains the reports upon the works in question, marked in blue.

The report on the harbor of Norfolk may be found at page 44; on Hampton River, at page 50; on Pagan Creek, at page 54; on Chickahominy River, at page 68, and on Blackwater River at page 59.

I also beg leave to submit a copy of Appendix G of my last annual report, which contains the report on the improvement of Norfolk Harbor for the year 1877, marked in blue at pages v and 363.

Very respectfully, your obedient servant,

A. A. HUMPHREYS,
Brigadier-General and Chief of Engineers.

Hon. GEO. W. McCRARY,
Secretary of War.

APPENDIX W 13.

SURVEY OF THE HARBOR OF NORFOLK, VIRGINIA.

UNITED STATES ENGINEER OFFICE,
Washington, D. C., February 15, 1875.

GENERAL: The appropriation bill approved June 23, 1874, contains a clause directing an examination and survey to be made of Norfolk Harbor, Virginia. After an inspection of the harbor, I directed a survey to be made, and I have now the honor to submit my report, together with the map made by Mr. Elliott and Mr. Michler, assistant engineers.

After consultation with prominent citizens of Norfolk, I concluded that the object of the survey would be best attained by confining my examination to that part of the harbor which was the subject of complaint. This limitation was necessary on account of the small sum at my command. By general agreement, I found that the bar at the mouth of the Eastern Branch was regarded as the chief obstruction to navigation within the harbor.

THE BAR.

The Elizabeth River is formed by two branches, known as the Southern and the Eastern Branch. The first, on account of the greater length and volume of its water, generally takes the name of the river. The bar is formed at the mouth of the Eastern Branch, extending from a point opposite the ferry at the foot of Market street to 750 feet above, and 150 feet below, measured on the axis of its channel; or, if measured 150 feet from the wharves and parallel with them, it extends 900 feet above the ferry and 1,200 below, manifesting a decided tendency to shoal along the wharves. It may be regarded as being formed by two combinations of forces, one combination causing the shoaling along the front of the wharves, the other giving rise to the bar which lies farther out in the channel. The shoaling I regard as due to the deflection of the ebb at the upper part of the wharves, more particularly by Old Dominion, Cromwell, Graves, and the railroad wharves, and by the retardation of the current along the entire wharf-front. The bar which occupies the main channel is partly due to the county bridge 800 yards above, and in a large degree to the angle of confluence of the Southern Branch. The two branches of the river meet at an obtuse angle, giving rise to opposing currents at ebb-tide, the greater of which holds its way, while the lesser branch is retarded, causing a deposit of the material held in suspension or rolled along the bottom.

The Southern Branch has greater length, larger tributaries, and consequently greater tidal capacity. Just above the point of confluence it is contracted to nearly one-half the average width of the Eastern Branch. These conditions increase the predominance of the river, and confine the bar to its present position within the mouth of the Eastern Branch. The flood seems to exert some influence, but the exact nature of it cannot be determined without careful measurements of subsurface velocities. As has been stated, the two branches meet with opposing currents. The confluence should be at an acute angle, and the work to effect this result must involve considerable expense. To accomplish this change it would be necessary to rectify the wharf-front of the city of Portsmouth, commencing at the southern point and extending 1,200 feet above, pushing the entire front back, until at the southern point it will be about 30 feet in the rear of its present position. The line should then be continued by dredging from the point of the wharf to the 25-foot curve of depth, turning on a gentle curvature to the left hand. Between this line and the channel the material should be dredged to a depth of 20 feet.

These operations involve an interference with riparian rights, and require a large amount of dredging. I regard them, however, as essential parts of any plan for the correction of all the forces which co-operate to form the bar. As it is probable that the depth required may be obtained by operations conducted within the Eastern

Branch, the complex questions involved in making any change in the mouth of the Southern Branch may for the present be left out of consideration. This omission may not conduce to the permanence which might otherwise be obtained, but it is possible to attain by other means a depth which may endure sufficiently long to add enormously to the commercial facilities of the harbor.

The county bridge over the Eastern Branch has the effect of increasing the velocity of the current, which takes up its load at the bridge and deposits it as the stream expands on the bar below. For the same reason any material in suspension is deposited on the bar.

This bridge is owned by private parties, who, I have been informed, are willing to sell it, and the city authorities have taken the preliminary steps for its purchase and removal. In order to benefit the harbor to the fullest extent, the causeway should be removed at the same time as the bridge.

When this is done the city will have gained an addition to its water-front of about 1,000 feet, a matter of considerable importance in a harbor so contracted as that of Norfolk. It is evident, from this account of the formation of the bar, that in order to preserve the depth which may be obtained by the excavation of a channel, the bridge should be removed. This measure was recommended by Capt. Charles B. Phillips, Corps of Engineers, in a report made to Col. William P. Craighill, Corps of Engineers, and dated June 30, 1874. Captain Phillips's account is very clear:

"We find (he observes) slight and rather peculiar changes in the bed of the harbor between the county bridge across the Eastern Branch and the confluence of the two branches. We find a slight tendency of the channel to deepen immediately and for some little distance below the bridge.

"Farther down (some 800 yards below the bridge) shoaler water, which, as far as is known, has always existed, is encountered, and continues until the influence of the Southern Branch is felt. The depth of the shoaler water referred to has changed but little since the soundings were taken by the Coast Survey. It appears to have filled in very slightly. Its worst feature seems to be that the shoal is slowly extending along to the wharves immediately below the ferry. I attribute these changes to the existence of the county bridge across the Eastern Branch. The stream is considerably contracted at this point by a long causeway, which constitutes the southern extremity of the bridge."

In this statement Colonel Craighill concurs.

DREDGING.

I have laid down upon the maps lines indicating the proposed cuts, three in number, differing mainly in width. The first occupies the main channel, and has a width of 330 feet; the second extends from the main channel nearly to the wharf-front, having a width of 480 feet; the last combines a cut of 100 feet through the main channel, with one of 300 feet along the front of the wharves. The commercial value of these channels will be in proportion to their cost.

I give below the probable cost of improving the channel in Norfolk Harbor, arranged in the order of their importance.

I. For dredging a trapezoidal area between the main channel and the wharves (designated on the map K L F G).

172,900 cubic yards, at 50 cents	$86,450
Contingencies, 10 per cent	8,645
Total	95,095

II. For dredging a cut, 100 feet wide, through the main channel, and another, 300 feet wide, along the wharf-front.

157,800 cubic yards, at 50 cents	$78,900
Contingencies, 10 per cent	7,890
Total	86,790

III. A cut through the main channel, 330 feet wide (designated on the map A B C D E).

72,000 cubic yards, at 50 cents	$36,000
Contingencies, 10 per cent	3,600
Total	39,600

The material excavated may be deposited on Craney Island Flats, or in Tanner's Creek, about five miles distant. I am informed that the common council desire it to fill up the low grounds in the city. The question should be finally decided upon economical considerations, and with due regard to riparian rights, if Tanner's Creek is selected as the place of deposit.

I have been expressly requested by the harbor committee to mention the importance of promptly establishing a port-warden's line for the city and county. An act has been proposed and will probably receive the sanction of the legislature of the State of Virginia, authorizing the appointment of commissioners from the city and county of Norfolk, and from the city of Portsmouth, who shall be empowered to establish such rules and regulations as they may think necessary for the conservation of the navigation and for the pilotage and policing of the harbor. Regulations of this kind have been found necessary in all harbors of commercial importance. The question is a national one and merits favorable consideration by Congress. Its importance is further enhanced by the fact that the government holds large reservations, and occupies an important naval station, ship-yard, and hospital in the harbor.

In relation to this subject I will again quote Captain Phillips:

"Concerning the running out of wharves opposite this point, a precedent, justifying the continued encroachment of the wharves upon the channel from the Norfolk side, seems to have been established in the result of the recent case of litigation connected with Pfeifer's wharf. The injunction which was asked for, to prevent the building of this wharf, was not granted by the courts. A causeway 175 feet in length now extends out from the shore to 9 feet of water. It is unquestionable that this wharf and causeway detract much from the benefit formerly derived from the scouring effect of Paradise Creek and the bay included between the wharf in question and Town Point."

In relation to changes in the depth of the Southern and Eastern Branches, and to the variations of depth and in the shore-line, both within and without the harbor, further observations are necessary in order to report with precision. I cannot do more than allude to some wrecks which lie on the south side of the harbor below the bridge. Examination into this matter may be included in a general examination of the harbor for the purpose of fixing the port-warden's line, if Congress see proper to order a survey. If it meets your approval, I would suggest that $5,000 be asked for this object.

Before referring to the trade of Norfolk, I would state that the two smaller estimates which have been given above are parts of the larger estimate. The entire plan can therefore be executed in successive parts if Congress see fit to grant the necessary funds. The deposit which is found along the wharf-front will require the repetition, at regular intervals, of the work of removal, and these operations should be at the expense of the city or of the individual proprietors.

The harbor of Norfolk, taken in connection with the excellent anchorage in Hampton Roads, has justly been regarded as one of the finest on the continent. The depth of its channels, security of its anchorage, capacity, freedom from ice, facility of entrance and departure, combined with a central geographical position at the mouth of the largest bay in the country, confer on it an unquestionable commercial superiority.

The great cities at the head of the bay are perfecting their railroad connections with the grain-growing region of the West, and the effect is already apparent in the large accession to the trade of the harbors on the bay with home and foreign ports. I have compiled some of the principal commercial statistics showing how remarkable has been the growth of the trade.

These statements show that the number of bales of cotton received at the port of Norfolk has increased from 6,174 bales received in 1858 to 472,446 bales received in 1874. The increase in 1873 over the previous year amounts to 68,000 bales. The total shipment direct for foreign ports during three months commencing October 28, 1874, was 48,867 bales. The increase in the number of vessels during the past year amounts to 1,067, the total number of all kinds trading at this point being 10,045. Among the other articles of trade are corn, oats, staves, cotton fertilizer, and oysters. In the packing of oysters 1,200 men are engaged. One million five hundred thousand six hundred and seventy bushels of oysters were inspected last season, which does not, it is said, include a large quantity that is exempt from taxation.

A large amount of trade passes through the Chesapeake and Albemarle Canal, but the statistics showing its increase during the past year are not at hand. According to the statement which accompanies the report of Colonel Craighill, the number of steamers during the year closing September 30, 1873, was 2,075, the number of vessels of all kinds amounting to 5,770. The receipts for tolls and towing during the same period amounted to $84,839. Between October 1, 1873, and June 30, 1874, the number of vessels passing through the canal amounted to 4,384. The total number of feet of lumber passing the canal during the last fiscal year was 28,120,768; the total number of bales of cotton passing during the same period was 44,542, being a gain of 12,352 bales over the previous year. The amount of tonnage and other details are given in full in the report of Colonel Craighill, printed in the volume of Engineer Reports for 1874.

Enough has been said to prove the remarkable increase of the trade of the port of Norfolk.

Very respectfully, your obedient servant,

S. T. ABERT,
United States Civil Engineer.

Brig. Gen. A. A. HUMPHREYS,
Chief of Engineers, United States Army.

COMMERCIAL STATISTICS.

The following statistics are compiled from a statement of the trade of Norfolk by C. W. Grandy & Sons, cotton-factors:

"Such has been the growth of the receipts with which Norfolk now stands authoritatively accredited, that she has risen from the fifth port since 1872 to the *third* rank in 1874, which position and dignity are now assigned her among the cotton-ports of the country, being exceeded *only* by New Orleans and Savannah, and following close upon the heels of the latter.

Net receipts of cotton at this port each year since 1858:

	Bales.
1858–'59	6,174
1859–'60	17,777
1860–'61	33,193

1861 hostilities ensued. No record to be found. To 1865, war between the sections.

	Bales.		Bales.
1865–'66	59,096	1870–'71	302,930
1866–'67	126,287	1871–'72	258,730
1867–'68	155,591	1872–'73	405,412
1868–'69	164,789	1873–'74	472,446
1869–'70	178,352		

The export trade has increased from 733 bales for the year ending 1865–'66 to 20,721 bales during the past season; and already for the last three months of the past year this port has shipped to Europe direct 48,867 bales; and where we cleared *one* ship the previous season we now clear *fifteen* ships between this port and Liverpool and the continental ports direct.

FOREIGN SHIPMENTS.

Shipments during this season from this port direct to English and continental ports, commencing September last, to the present time:

To Liverpool:

	Tons burden.	Bales.
October 28, 1874, Norwegian bark Attila	447	1,462
November 11, 1874, British ship British America	1,085	3,428
November 15, 1874, Norwegian bark Rothrary	686	2,008
November 27, 1874, Norwegian bark Helen Sands	560	1,790
November 28, 1874, British steamship Dawn	1,106	2,917
December 1, 1874, British ship Oasis	1,182	4,106
December 4, 1874, steamship Ontario	3,200	6,000
December 10, bark Olive Mount	935	3,125
December 11, 1874, bark Minnie Hunter	457	1,528
To Bremen:		
November 18, 1874, Norwegian bark Alliance	460	1,403
Total direct shipments cleared		27,767

For Liverpool:

Vessels in port loading not yet cleared:

	Bales.
Ship Ella and Thayer	3,550
Ship Voyager	5,000
Ship John Mann	4,100
Bark Troubadour (balance of cargo of corn)	500
Ship Uncle Joe	2,800
Bark Ocean (balance of cargo of corn)	800
Steamship San Antonio	2,500
For Amsterdam:	
Bark Mellrune	1,850
	21,100
Total cleared	27,767
Total direct shipments this season, cleared and loading	48,867

DIRECT SHIPMENTS.

Shipments each year since the war direct from Norfolk to Liverpool and the continental ports:

	Bales.		Bales.
1865–'66	733	1871–'72	4,6[illegible]
1866–'67	14,168	1872–'73	8,2[illegible]
1867–'68	8,279	1873–'74	20,3[illegible]
1868–'69	7,527	Direct shipments for the last three months, commencing October 1, 1874, to date	48,[illegible]
1869–'70	4,745		
1870–'71	5,142		

There are four large steamers (running constantly) to Boston and three to Providence. The coastwise shipments from this port last season to Boston, Providence, &c. amounted to 422,828 bales.

The following figures are taken from the Merchants and Mechanics' Exchange Report, 1860:

Total receipts of cotton at this port from all sources previous to the war.

Years.	Coastwise.	Foreign.	Total
	Bales.	*Bales.*	*Bales.*
1858	6,174	....	6,17[illegible]
1859	17,488	289	17,[illegible]
1860	32,941	252	33,1[illegible]
Total	56,603	541	57,14[illegible]

Receipts for three years since the war.

Years.	Coastwise.	Foreign.	Total
	Bales.	*Bales.*	*Bales.*
1872	254,043	4,687	258,7[illegible]
1873	397,130	8,282	405,4[illegible]
1874	418,328	49,243	467,5[illegible]
Total	1,069,501	69,212	1,131,7[illegible]

Norfolk and Portsmouth now have three powerful first-class cotton-presses, and all these have been erected within the past few months.

The steam-tonnage of this port, running to Boston, Providence, New York, Philadelphia, Baltimore, up the James, York, Rappahannock, Potomac, and other Virginia rivers, and to North Carolina, is 32,082 tons. Cotton taken on local account, 1871–'72, 55,000 bales; 1872–'73, 75,000 bales; 1873–'74, 95,000 bales.

Comparative statement of shipping for years ended June 30, 1873–'74, compiled in the office of the Norfolk Landmark:

Years.	Steamers.	Ships.	Barks.	Brigs.	Schooners.	Sloops.	Barges.	Total.
1873	3,371	......	22	22	3,632	1,576	355	8,9[illegible]
1874	3,722	2	22	24	4,320	1,650	305	10,0[illegible]
In favor of 1873	......	......	......	......	......	......	50	......
In favor of 1874	351	2	......	2	688	74	......	1,[illegible]

Norfolk is connected with the interior by two great railroads: the Atlantic, Mississippi and Ohio Railroad, with western connections to the Pacific; and the Seaboard and Roanoke Railroad, with southern connections to the Gulf of Mexico; also, by the James River steamers with the Chesapeake and Ohio Railroad to the great Northwest. and with foreign and domestic ports by steamship-lines; and by means of the Albemarle and Chesapeake and the Dismal Swamp Canals alone, over eighteen hundred miles of inland navigation are tributary to this port.

The population of the city is 25,000; including Portsmouth, Berkeley, &c., 40,000. The estimated real value of assessable property in Norfolk is $17,000,000. Lumber and staves have a most important place in the list of exports; the shipments in staves alone in the past year were 4,107,780. The oyster-packing business requires the services of 1,200 men to fill the orders received; 167,350 gallons of opened oysters and 57,630 bushels of oysters in the shell were shipped by the packers the last season; 1,500,667 bushels of oysters were inspected, which does not include all taken, as a large quantity are exempt from taxation, and consequently are not inspected.

Respectfully submitted.

S. T. ABERT,
United States Civil Engineer.

W 14.

SURVEY OF HAMPTON RIVER, VIRGINIA.

UNITED STATES ENGINEER OFFICE,
Washington, D. C., February 22, 1875.

GENERAL: A survey and examination of Hampton Creek was ordered in the appropriation bill for the improvement of rivers and harbors, approved June 23, 1874.

After a personal examination of the creek, I directed a survey to be made by Mr. A. K. Michler and Mr. W. H. Powless, Assistant Engineers. The detail of their work is given on the accompanying map and in Mr. Michler's report, hereto appended. It is only necessary for me to submit a few general considerations and an estimate based on these sources of information, and on the information derived from the charts made by the United States Coast Survey.

Mr. Michler states very clearly the causes at work in the formation of the bar at the mouth of the creek. The survey was limited to this, which is the only obstruction to navigation at this time.

The mouth of the creek is but little more than twelve miles from Norfolk, and about two miles from Fortress Monroe. The landing is about one mile from the mouth. A bridge, without a draw, connects the town of Hampton with Fortress Monroe. No examination was made of the effect of the bridge upon the depth of water below it, but it is proper to caution those interested against the danger of such structures if built without sufficient room for the passage of the water between the piers, and also against any injudicious occupation of the tidal space.

A national military asylum for disabled soldiers and a normal school for persons of color are situated on the border of the town. Nearly all of the products of three counties are said to be shipped from this point.

Mr. Michler's account of the bar is very judicious. The channel over it is maintained by the ebb current, and any work of deepening must increase the force which preserves it. The channel should be dredged with a straight cut, having a width of 150 feet and a depth of 9 feet. These dimensions will permit the bottom of the cut to assume the natural slopes without seriously affecting the depth. The estimate of the cost will be as follows:

28,650 cubic yards dredging, at 50 cents	$14,325 00
Contingencies, 10 per cent	1,432 50
	15,757 50

This estimate is not large in view of the exposed condition of the bar. The place of deposit is more exposed than the bar. The flats which might be employed for this purpose are navigated in every direction, and a large area is used as an anchorage by coasters while waiting for a favorable wind. It may be necessary, therefore, to deposit the material dredged near the deep water, about two miles distant, and in doing so considerable difficulty will be experienced in handling the dumping-scows in windy weather. The estimate will about cover the cost of overcoming these obstacles.

Although Hampton has but one good wharf and but limited harborage, it yet drives a thriving business. It is said to be the outlet for the produce of three counties. The number of arrivals and departures of steam and sail is given at 1,450 vessels. The exact number is not known. One steamer of 630 tons touches daily while plying between Norfolk and Pagan Creek. The mean range of water is from 3 to 7 feet, but the wind sometimes reduces the depth on the bar to such an extent that the vessels are delayed for one or two days.

The amount of trade is given in the accompanying letters of Mr. Heffelfinger.

The value of merchandise received in the county is stated to be $500,000. Among the principal articles shipped are: 150,000 feet of lumber, 600,000 shingles, 10,000 bar-

rels of flour, 60,000 bushels of sweet potatoes, 60,000 bushels of oysters, and other articles.

The population of Elizabeth City County is 8,300; Hampton is the county-seat, with a population of about 1,200. York and Warwick, the adjacent and tributary counties, have together a population of about 8,700.

The town has a steam grist-mill, a steam flouring-mill, and a sash and door factory.

A map of the bar at the mouth, on a scale of 100 feet to the inch, accompanies this report; also a map showing the connection of the village of Hampton and Fortress Monroe, on a scale of $\frac{1}{20000}$.

Very respectfully, your obedient servant,

S. T. ABERT,
United States Civil Engineer.

Brig. Gen. A. A. HUMPHREYS,
Chief of Engineers, U. S. A.

REPORT OF MR. A. K. MICHLER, ASSISTANT ENGINEER.

PORTSMOUTH, VA., *February* 10, 1875.

SIR: I have the honor to submit the results of a survey and examination of Hampton River, Virginia, made in conformity with your instructions December 2, 1874, by Mr. W. H. Powless and myself.

Hampton River is one of the numerous streams forming Hampton Roads, into which it flows about two miles northwest of Old Point Comfort. It is to a great extent the only source of outlet for the produce of a portion of Warwick and York Counties, and Elizabeth City County, of which Hampton is the county-seat. Hampton is quite a thriving little town of 1,200 inhabitants, situated one mile from the mouth of the river. Since the war it has been much improved, and greatly increased in population and property valuation. The National Military Asylum for disabled soldiers, and the colored normal school, are the principal public institutions. It contains three saw-mills. In addition to the numerous sailing-vessels, there is a fine daily steamer plying between the town and Norfolk, Portsmouth, Old Point, and Smithfield. For detailed information concerning the shipping, I respectfully refer to the appended statistics, kindly furnished by Mr. Heffelfinger, a gentleman of undoubted reliability.

The examination was confined to the bar at the mouth of the river, as between this point and Hampton there is a continuous channel, 60 feet in width and 8 feet in depth at mean low water. At Hampton navigation is checked by a bridge across the river having no draw.

The formation of the bar may be attributed to various causes, all of which are to some extent worthy of consideration. The grounds of the Military Asylum terminate along the mouth of the river by a bank averaging 8 feet in height. The bank has been gradually wearing away from the action of the waves at times of heavy seas, and to such an extent as to cause the authorities of the Home to be fearful for the safety of the property, and to make them endeavor to have a riprap built to prevent further encroachments. The material thus washed away may conduce to some extent to the formation of the bar, but that this has but little influence I am persuaded, from the character of the material forming the bar being hard, white sand. It is also attributed to the washings from what is known as Hampton Bar. This bar makes off from Old Point Comfort in a southwesterly direction, and is about two and one-half miles long, crossing the direction of the river nearly at right angles and about a mile and a quarter from the mouth. There are only from 2 to 3 feet of water on it at low water. Strong easterly winds, especially from the southward, cause very heavy seas to roll over this bar, and particles may become dislodged and by the flood-tides carried to and deposited at the point examined. It is said that at one time buoys were placed at the mouth of the river, and perhaps the anchors were left, and laid the foundation for the bar. Nothing was found of this kind in the hurried examination made.

The material of the bed within that portion of the river shown on the accompanying sketch is very soft mud. The most probable cause, it appears to me, is as follows: It will be observed from the United States Coast Survey of this section that the water between Hampton Bar and the mainland varies in depth from 8 to 12 feet, and that the channel between the bar and Old Point is very narrow.

It seems probable that the fine particles of sand forming the bed may have been brought down from the James River by the strong ebb-tides, and the narrow channel at Old Point preventing a free egress. the material deposits itself along the shore at the asylum until at last it has encroached upon the channel at the mouth of Hampton River. This view is assisted by the fact that the portion of the bottom to the left of the channel is mud, as shown in the map, and that between the channel and the asylum grounds sand. If either the first or latter view be the correct one, a dike or wicker-work fence on the east side would perhaps be an advantage.

In order to secure a correct determination, it would be necessary to make careful observations of the tides and winds, their effect upon the different places mentioned, and the character of the material. Whatever may be the cause, the accretion has been very slow, Captain Shermerhorn, of the daily steamer, informing me that no perceptible change has taken place in the last seven years.

The soundings taken are reduced to mean low water, as determined simply from the one day's observations, having taken the mean low-water marks pointed out to me by the boatmen of the locality. The rise and fall of the tides coinciding so nearly with that given for Old Point Comfort by the United States Coast Survey, and there being no wind perceptible, I presume my zero to have been correctly established. Sufficient examination was made to assure me that the 8-foot curve reached without the mouth was continuous.

It is desired that a channel be cut to a depth of 8 feet at low water, and it is believed that when excavated it will remain open for a long time.

I am, sir, very respectfully, your obedient servant,

A. K. MICHLER,
Assistant Engineer.

Mr. S. T. ABERT,
United States Civil Engineer.

COMMERCIAL STATISTICS.

1.

HAMPTON, VA., *February* 11, 1875.

SIR: I beg leave to submit for your information the following report in regard to the shipping interests of Hampton River. The statistics accompanying this report do not claim to be exact, but are based on estimates made from the most reliable information accessible to me.

Statement of arrivals and departures of sailing-vessels and steamers in Hampton River for one year.

Sail-vessels	1,125
Steamers	325
Total	1,450

Draught of water of vessels arriving and departing, from 3 feet to 9 feet.

Tonnage of same, from 12 to 250 tons for sail-vessels; and 630 tons average for steamers.

Estimate of the amount and character of merchandise received and shipped from the wharves in Hampton River for one year.

Receipts:

60,000 bushels of oysters.
12,000 bushels of corn.
1,500 bags guano and phosphate.
10,000 barrels flour.
1,500 tons coal.
600,000 shingles.
200,000 laths.
1,500,000 feet of lumber.
800 tons of ice.
140,000 barrels and cases of liquors, provisions, and general merchandise.

Shipments:

5,000 bushels wheat.
60,000 bushels sweet and Irish potatoes.
60,000 bushels oysters.

All vessels drawing over 6 feet of water are liable to detention at Hampton Bar, and *are detained*, unless they arrive at high tide. While waiting for high tide, vessels frequently experience a change of wind, and thus are detained for one or two days.

I am, sir, very respectfully, your obedient servant,

JAC. HEFFELFINGER.

Mr. S. T. ABERT,
United States Civil Engineer.

2.

HAMPTON, VA., *February 12*, 1875.

SIR: I submit for your information the following statistics, supplementary to my report of the 11th instant:

Population of Elizabeth City County, including the town of Hampton (census 1870)	8,303
Present population of Elizabeth City County, including Hampton (estimated)	9,200
Number of licensed merchants in Hampton	63
Number of licensed merchants in county, exclusive of Hampton	22
Total in county	85
Population of territory tributary to Hampton for supplies of merchandise, post-office, &c., including the eastern portions of York and Warwick Counties (estimated)	11,800
Value of merchandise received and sold in the county (estimated)	$500,000

Mills in Hampton: Steam grist-mill, 1; steam planing-mill, 1; steam sash and door mill, 1.

Respectfully submitted.

JAC. HEFFELFINGER.

Mr. S. T. ABERT,
United States Civil Engineer.

W 15.

EXAMINATION OF PAGAN CREEK, VIRGINIA.

UNITED STATES ENGINEER OFFICE,
Washington, D. C., March 1, 1875.

GENERAL: A survey and examination of Pagan Creek, Virginia, was ordered in the appropriation bill for the improvement of rivers and harbors, approved June 23, 1874, and this duty being assigned to me by Engineer Department letter under date of July 9, 1874, I have now the honor to submit my report.

Pagan Creek is a tributary of the James River, into which it empties twelve miles from its mouth, and about twenty miles from Norfolk. It is navigable as far as Smithfield, a distance of five miles. It flows wholly within Isle of Wight County. This county contains 57,517 acres of improved land, valued at $1,145,148. The estimated value of the farm-products is $373,989, and of the live stock at $146,407, according to last census.

Pagan Creek is formed by Cypress Creek and Smithfield Creek, which unite about four and three-quarters miles from the mouth and one-fourth of a mile below the town of Smithfield. For its entire length it winds through salt-marshes and mud-flats, which now occupy the ancient tidal area, once filled by the creek. The marshes seem to have been formed by the sediment of the two tributary creeks and the James River, deposited upon the oyster-beds. These beds sometimes grow to the height of mean tide, and are further increased by the *débris* of broken shells which are heaped up by the winds. This effect is frequently observed in the sounds of Carolina. The channel is said to have maintained its depth for many years. If this be true it will not be difficult to keep an open channel by a repetition of the dredging at long intervals.

Except upon the bars the depth of water in the creek varies from 8 to 30 feet. Between the mouth and Smithfield four bars obstruct the navigation. The upper or Bridge Bar, which is the worst, occurs at the confluence of the creeks, where the channel makes a sudden turn. A depth of 4½ feet can be carried over it at low water. The obstructions from the confluence channels can be easily corrected.

Wright's Bar is one and one-half miles from Smithfield. Here the creek expands from a width varying between 250 and 1,000 feet to a width of 4,800 feet, which it retains for one and one-half miles. In this distance three bars occur, close together, two of them designated as Wright's Bars, having on them about 5 feet of water at low water, and the third having 5½ feet at low water, known as Bob Shoal. All the bars are composed of soft mud and occasional oyster-beds, which are found of larger extent on the two last named.

To correct the effect of the broad expanse which is found between Wright's Point and Bob Shoal, a dike on the left of the channel, and perhaps another on the right, may be necessary, but it would be better to leave the question of its construction until further examination can be made. A deposit in process of formation by natural causes upon each side of the channel may supersede the necessity for the construction

of a dike, and it is probable that when the channel is excavated through Wright's Bar and Bob Shoal, the current will be sufficient to preserve the depth. As a more careful study of this part of the stream is necessary before a dike can be recommended, I have not included the cost of a structure of this kind in my estimate for the improvement of the creek. An examination can be made for the purpose of determining the propriety of its construction, during the progress of the work at other points. The question to be determined relates to the height, length, and position of the dike, or dikes, and to the manner of its construction. From inspection, I should, if dikes were necessary, estimate for aggregate length of about 4,500 feet, which might be built for $13,500. The general estimate, therefore, should be received as conditionally subject to an increase to the extent of the amount just stated.

The bar next in order, and the last, is found in the James River, at the mouth of the creek. Two channels afford a passage over it between the river and the creek. One of them my assistant, Mr. Michler, states has a suitable depth of water, and a width of 100 feet, but according to the pilots it is circuitous, obstructed by oyster-rock, and difficult of navigation at night. The channel proposed for improvement has a width of 100 feet. From its position, it is accessible at all hours. The low-water depth on the bar is between 3½ and 4½ feet, the range of the tide, during the survey, being unusually great, or about 4 feet. The average range of tide is 2.6 feet, but the low water established during the survey, being more favorable as a basis for estimating the depth of the cut, has been used for that purpose.

The cuts through the bars within the creek are estimated for a width of 60 feet and a depth of 8 feet. These depths will give a navigable channel to Smithfield, with a depth of from 6½ to 7 feet, which is sufficient for the present wants of the community. The assumed width of the cut is moderate, but the depth has been taken a little in excess of the ruling depth on the outside bar, in order to permit the mud to take its natural slope.

The probable cost of the work, estimated with the above dimensions, is as follows:

Bridge Bar, 6,000 cubic yards dredging, at 45 cents	$2,700 00
Wright's Bar, 5,000 Wright's Bar, 7,000 } 12,000 cubic yards dredging, at 40 cents	4,800 00
Bob Shoal, 12,000 cubic yards dredging, at 40 cents	4,800 00
Bar at the mouth, 27,000 cubic yards dredging, at 50 cents	13,500 00
Contingencies, 10 per cent	2,580 00
Total	28,380 00

If Congress desires to select the most obstructive bars for improvement, I would recommend the Upper or Bridge Bar, and the bar at the mouth, which could be improved at the same time. The cost of this part of the improvement would then be:

Bridge Bar	$2,700 00
Bar at the mouth	13,500 00
Contingencies, 10 per cent	1,620 00
Total	17,820 00

The other bars can be improved in the order of succession.

I submit herewith charts of Bridge Bar, Wright's Bars, and Bob Shoal, and the bar at the mouth; also, a general tracing of the map of the creek, made by the United States Coast Survey.

It will be observed, upon comparison of the charts of Mr. Michler and Mr. Powless with the localities of the bars marked upon the Coast-Survey chart, that a considerable difference exists. This is due to the extreme low water, caused by the winds, at the time of the survey.

The survey was made conjointly by Mr. Michler and Mr. Powless, assistant engineers.

Smithfield, the head of navigation, has a population of about 1,000 inhabitants.

It contains a ship-yard, saw-mill, and tram-way for the transportation of lumber from the swamp to the wharf. A river-steamer, the Hampton, of 630 tons, and drawing about 4½ feet of water, plies between Norfolk and the creek, making the round trip in two days. This steamer is sometimes seriously delayed when the winds concur with low water to reduce the depth upon the bars. In common with Norfolk, this place has experienced an increase of trade, and the trucking business, for which this region is favorable, has contributed largely to this result.

A letter of Mr. R. S. Thomas, also appended, seems to give a very fair statement of the trade of Smithfield.

Very respectfully, your obedient servant,

S. T. ABERT,
United States Civil Engineer.

Brig. Gen. A. A. HUMPHREYS,
Chief of Engineers, U. S. A.

COMMERCIAL STATISTICS.

SMITHFIELD, VA., *November* 28, 1874.

DEAR SIR: I have put myself to great pains to obtain from the most reliable sources correct information of the quantity and variety of products that are annually shipped from this place, and I herewith submit to you the result. It is based on the manifests of shippers, and can with confidence be relied on. From the statements furnished me, I find that the annual shipments from here average as follows, viz: 14.875 barrels of apples; 7,661 barrels of potatoes; 406 barrels of brandy; 483 barrels of vinegar; 875 barrels of sundries; 211,878 pounds of bacon; 321,335 pounds of dried fruit; 5,775 pounds of lard; 72,092 pounds of junk; 78,400 dozen eggs; 40,000 bushels of oysters; 5,000 cords of wood, &c.; 79,300 bushels of pea-nuts; 4,025 bushels of pease; 805 bushels of beans; 525 bushels of corn; 1,175 bushels of meal; 1,645 bushels of sundries; 441 cattle; 704 sheep; 10,834 chickens; 500,000 feet of lumber. And the return cargoes are: 14,077 barrels; 3,318 boxes; 6,216 bags; 15,359 packages.

If the bars in our creek were removed, not only would the present trade of this place be facilitated, but it would be greatly enlarged. The heaviest trade of this section is, and for the future will be, cord-wood and lumber. If our creek had a depth of 8 feet, vessels carrying 200 cords of wood and 200,000 feet of lumber could load at our wharves, while at present only those that carry 100 cords of wood and 100,000 feet of lumber can visit this place, and this at very serious risks, as they always have to go out at the very flood of the tide, and rarely ever escape getting aground on the well-known bars. It is these bars that make vessels generally trading here timid of coming, and entirely exclude others of heavier draught that would gladly seek the freight that anxiously awaits them. Not only do vessels drawing 7 and 8 feet of water frequently ground in our creek, but the Hampton, our daily steamer, that was built with special reference to the condition of our water, and draws only 4½ feet, is frequently most seriously inconvenienced; and twice since Messrs. Michler and Powless have been here she was so nearly grounded that we thought she would have to stop, and only forced herself over the bars with the utmost difficulty.

I sincerely hope (and I express the anxious wish of this section, and of all persons who trade with it) that the bars that impede the commerce of this place will be removed from our creek, and that an appropriation will be made by the general government large enough to give us a depth of 8 feet of water.

The above estimates do not include the cargoes of melons and the boxes of truck that are annually shipped from this place, concerning which I have no reliable data.

Very respectfully, &c.,

R. S. THOMAS.

Mr. S. T. ABERT,
United States Civil Engineer.

W 17.

EXAMINATION OF BLACKWATER RIVER, VIRGINIA.

UNITED STATES ENGINEER OFFICE,
Washington, D. C., March 3, 1875.

GENERAL: A survey and examination of Blackwater River was ordered in the appropriation for the improvement of rivers and harbors, approved June 23, 1874, and this duty being assigned to me by Engineer Department letter under date of July 9, 1874, I have now the honor to submit my report.

During the latter part of November I made a personal examination of the Blackwater River. From the representations made, the principal obstructions consist of snags, logs, and overhanging trees, and more particularly of a very sharp bend called George's Bend, about five miles below Franklin. As there has never been any improvement of this river, it was thought that an attempt to remove the logs would develop a large number of these obstructions, the accumulation of past years. The survey, however, has not sustained this expectation.

The Blackwater River has its source in Prince George County, about twenty miles southeast of Petersburg, Va. Its general direction is south, flowing along the borders of Surry, Sussex, Isle of Wight, Southampton, and Nansemond Counties. It unites with the Nottoway River, on the border of North Carolina, to form the Chowan River, which empties into Albemarle Sound. It is thirteen miles long, and forms a navigable connection between the sounds of North Carolina and the Seaboard and Roanoke Railroad at Franklin, where navigation is stopped by the railroad bridge.

This village, which is the largest on the river, has about 300 inhabitants, and is about forty miles from Norfolk. It contains a saw-mill with an annual capacity of 4,000,000 feet of lumber, a cotton-gin, telegraph and railroad offices, and a few stores.

New South Quay, about five miles below Franklin, and Cobb's Landing, two miles above the mouth and in the Nottoway River, are the principal shipping-points for the trade of the adjacent country.

Three steamers ply on the river, two of them belonging to the Albemarle Steam Navigation Company, and the third to Mr. John Hill, of Portsmouth. One of the company's steamers makes tri-weekly trips between Franklin, Edenton, and Plymouth, N. C., the other makes semi-weekly trips to Gatesville, N. C. Mr. Hill's propeller makes tri-weekly trips to Murfreesborough, N. C. The steamers carry down supplies and bring up the products of the country to Franklin, whence they are forwarded by rail to Portsmouth and Norfolk.

During the fishing-season a steamer is run especially to accommodate this trade. Mail for fifty post-offices in the counties bordering the Chowan, as I am credibly informed, is carried by the steamer Lota.

The Blackwater is a sluggish, tortuous, tideless stream, flowing for the most part through cypress-swamps, which near its mouth have a dense undergrowth of canes. The higher land, where it appears, is cultivated, or else covered with a growth of oak and pine. A slight rise of the river causes an overflow of an area of country. The rise of water from the heaviest rain does not exceed 3 or 4 feet. The high land comes to the river at distances of from 1,000 to 3,000 feet. The soil is well adapted to cotton and pea-nuts, which are the principal crops.

The width of the Blackwater varies from 100 to 275 feet, and its depth from 8 to 38 feet. As will be seen by an inspection of the map, no difficult bars obstruct its course. At one point the river is contracted by a bar, which should be dredged in order to give sufficient width to the channel. This bar is said to have been formed largely by sawdust brought down the river from the saw-mill at Franklin. An injunction, however, has been issued to prevent the operatives of the mill from throwing any more sawdust into the river, and it is now deposited on the adjacent low grounds. The removal of snags and the felling of overhanging trees constitute the principal improvements required to facilitate navigation. About one and four-tenths miles from the mouth, near two wrecks, are several piles, which should be removed. They stand in 17 feet of water, and about 75 feet from the shore. Several other piles, in other parts of the river, might be removed with benefit to navigation.

Navigation is also obstructed by several bends, but only one offers obstructions serious enough to warrant an estimate for its removal. This exception is found at George's Bend, about half a mile below New South Quay. The river at this point makes a sudden bend in the shape of an S. The mail-steamer (117 feet long) is obliged to stop in passing the bend, and I have seen the large steamers compelled to pass out a line in order to warp round the bend.

As the company intends to introduce a steamer 158 feet in length, the difficulty of passing this point will be much increased. It is proposed to cut off one of the points in the bend for a distance of 100 feet back, and to a depth of 7 feet. Although this would not remove the difficulty, it would considerably lessen it.

As the roots of cypress are difficult to remove, I have estimated the excavation at the average rate of $2 per cubic yard.

The following approximate estimate is respectfully submitted:

6,000 cubic yards dredging, at $2	$12,000 00
50 snags to be removed, at $16	800 00
Felling and removing trees	600 00
Removing twenty piles	100 00
Contingencies, 10 per cent	1,350 00
Total	14,850 00

To Mr. John Hill, treasurer of the Albemarle Steam Navigation Company, I am indebted for much information, and for assistance during the survey. A statement of the trade of the river has been offered by Mr. Hill, but has not yet been received.

The triangulation and topography were conducted by Mr. Elliott and Mr. Powless, and the hydrography by Mr. Turrill.

A general map of the river, on a scale of $\frac{1}{10000}$, accompanies this report.

Very respectfully, your obedient servant,

S. T. ABERT,
United States Civil Engineer.

Brig. Gen. A. A. HUMPHREYS,
Chief of Engineers, U. S. A.

W 20.

EXAMINATION OF CHICKAHOMINY RIVER, VIRGINIA.

UNITED STATES ENGINEER OFFICE,
Washington, D. C., May 24, 1875.

GENERAL: A survey and examination of the Chickahominy River was ordered in the appropriation bill for the improvement of rivers and harbors approved June 23, 1874, and this duty being assigned to me by Engineer Department letter under date of July 9, 1874, I have now the honor to submit the following report of a personal examination:

This river rises in Henrico County, Virginia, about twelve miles northwest of Richmond; flows southeast, having Kent and Hanover Counties on the north, and on the south Charles City County, and empties into the James River forty miles from its mouth, near Newport News.

The upper part of the river, as far as Forge Bridges, is confined to one or more small channels, flowing through swampy bottom-land which, on the Mechanicsville road, is crossed by a causeway and six bridges.

At Long Bridges the county road crosses the forks of the river. Between Long Bridges and Forge Bridges, a distance of ten miles by the river, the main channel, 30 to 80 feet wide, wanders through a cypress-swamp, which varies from one half to one mile in width. Its course is tortuous, intricate, broken by cut-offs and obstructed by trees, snags, logs, and drift. The depth varies from 5 to 13 feet during eight months of the year, to 18 inches or 2 feet during the remaining four months of the dry season. The floods have a range of 8 feet above low-water. This part of the river is so obstructed by logs and drift that it is with difficulty that a small skiff can be drawn through or over them. These obstructions dam back the water, and submerge a large tract of land. Their removal will change the regimen of the river, which is now impassable, and will improve the salubrity of the adjacent land.

About four miles above Forge Bridges the logs have been partially removed by the lumber-men engaged in rafting oak timber. With proper appliances, the channel beween Long and Forge Bridges can be cleared for $300 per mile, or a total of $3,000 for the ten miles.

Forge Bridges spans the old channel of the river, now impassable, and bridges the canal, which cuts off a bend and affords a channel for barges and timber-rafts. This canal is said to have been constructed in colonial days by the British government, which levied a heavy tax on the tobacco transported from this section of the State.

The head of lighter or schooner navigation is one-half a mile below Forge Bridges, at the end of the canal.

The name of Forge Bridges has, until recently, been a mystery to every one. Soanes's Bridge and Jones's Bridge has been substituted, but the traditionary name has been Forge Bridges. About three years since, a flood washed away the dam of Townsend's mills (about one-half a mile above the bridge), and revealed the foundation of an old forge with trip-hammer, slabs of iron, and other evidences of a forge. It was then recollected that the locality bore the name of Providence Forge in colonial times.

From Forge Bridges to Holly's Landing is 7 miles. For much of this distance the removal of logs, trees, and drift will be necessary. From Forge Bridges to Windsor Shades is 19 miles. In this distance the river is tortuous and narrow, varying from 60 to 70 feet in width, and flows between low swampy banks. The bar at the Shades is formed of hard sand and is about 300 feet long, with a depth of 3 feet at low-water.

Immediately below this bar a creek enters the river, and seems to exert some influence in its formation. I cannot state without a more careful examination whether any advantage would result from changing its angle of confluence. The bar can be easily dredged to 7 feet at low-water.

Two miles below Windsor Shades is Binn's Bar, having 3 to 4 feet at low-water. The dredging this bar to a depth of 6 or 7 feet at low-water would enable large wood-schooners to come up to Windsor Shades landing. At present these vessels after partially loading have to drop below Binn's to complete their load. This is not only very expensive, but a great deal of delay is often occasioned, if the wind blows strongly from almost any direction.

From Binn's Bar to the mouth is 25 miles. For this distance a depth of from 12 to 30 feet can be carried as far as the bar, on which there is 11 feet at low water.

AGRICULTURE, LAND, TIMBER, ETC.

Above Forge Bridges there is much valuable cypress and oak timber, but the extent of the forest could not be ascertained. The lands along this point of the river are inferior. The average yield per acre varies from ten to forty bushels of corn, and from six to ten bushels of wheat. With few exceptions, the land is not well cultivated. Marl is little used. Much of the land has been overflowed by the water dammed by

the accumulation of logs and drift above Forge Bridges, and their removal will not only benefit navigation, but will improve the salubrity of the adjacent country.

A general belief exists that the Chickahominy, Pamunkey, and Mataponi Rivers have been rapidly decreasing in depth in the upper portions during the last fifty years. Reduction of depth from the deposition of sediment must take place in all rivers flowing through light alluvial soils, and this deterioration must be more rapid after the soil has been exposed by the removal of the forests and the loosening of the soil by cultivation. The consequent reduction of the depth in the channel can be partially corrected by the removal of the deposits, or by causing them to take place at points outside of the channel.

A similar deterioration has been observed in the European rivers, which has been attributed to other causes than those above named. Mr. W. G. Wex, in a paper read before the Geographical Society of Vienna, states that certain German rivers are much lower than they were fifty years ago; that the Elbe has decreased 17 inches; the Rhine, 24 inches; the Oder, 17 inches; the Vistula, 26 inches; and the Danube, 55 inches. This decrease is assigned to the devastation of the forests and the consequent decrease of atmospheric moisture—a cause often assigned, but not yet demonstrated. In some localities the change of level in the surface of the land by gradual upheaval would have to be considered. But whatever may be the causes operating, there can be little doubt as to the effect of the sediment brought down by the annual rain-floods.

The value of the annual products of timber shipped is—

Cord-wood	$120,000
Lumber	28,000
Ship-timber	80,000
Total	228,000

The quantity of grain shipped has not been ascertained.

The following statement shows the distances from Long Bridges to the places named: Long Bridges to Forge Bridges, 10 miles; to Holly's Landing, 17 miles; to Wynne's, 29 miles; to Windsor Shades, 30 miles; to Osborn's, 31 miles; to Binn's Bar, 32 miles; to mouth of river, 56 miles.

The following approximate estimate is submitted:

Windsor Shades	1,700 cubic yards dredging;
Binn's Bar	5,000 cubic yards dredging;

7,700 cubic yards dredging, at 50 cents	$3,850
16 miles to be cleared of logs, snags, &c., at $300 per mile	4,800
	8,650
Add 20 per cent. for contingencies	1,730
Total	10,380

A general map of the river and a hydrographic chart of the lower part of same accompany this report.

Very respectfully, your obedient servant,

S. T. ABERT,
United States Civil Engineer.

Brig. Gen. A. A. HUMPHREYS,
Chief of Engineers, U. S. A.

[EXTRACT FROM THE ANNUAL REPORT OF THE CHIEF OF ENGINEERS TO THE SECRETARY OF WAR.]

OFFICE OF THE CHIEF OF ENGINEERS,
Washington, D. C., October 12, 1877.

* * * * * * *

IMPROVEMENT OF NORFOLK HARBOR.

* * * * * * *

Norfolk Harbor, Virginia.—An appropriation of $35,000 was made in the river and harbor act of August 14, 1876, for the improvement of this harbor, the work proposed being dredging a channel through the bar at the mouth of the southern branch of

Elizabeth River. For the continuation of this work and for the removal of wrecks $25,000 are asked by the engineer in charge.

Amount appropriated by act approved August 14, 1876	$35,000 00
July 1, 1877, amount expended during fiscal year	289 15
July 1, 1877, amount available	34,710 85
Amount (estimated) required for completion of existing project	25,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1879	25,000 00

* * * * * * *

G 8.

IMPROVEMENT OF NORFOLK HARBOR, VIRGINIA.

In the act approved August 14, 1876, an appropriation of $35,000 was made for the improvement of this harbor. The work was advertised in the usual manner and the following bids were received and opened on June 20 at 12 m.:

Number.	Name and address.	Dredging, per cubic yard.	Time of— Commencement.	Time of— Completion.	Average daily work, cubic yards.	Number and kind of machines.
1	Morris & Cumings, Dredging Company, New York City.	$0 13	Oct. 1, 1877	Dec. 30, 1877		
2	E. R. Seward, Albany, N. Y.	16	July 15, 1877	Dec. 30, 1877	2,000	1 clam-shell or 2 dippers.
3	Clinton Stephens, Brooklyn, N. Y.	24	July 10, 1877	July 10, 1878		
4	Morris F. Brainard, Albany, N. Y.	11¼	Sept. 1, 1877	Feb. 15, 1878	800 to 1,200	1 or more Starbuck or 1 clam-shell.
5	Sidney F. Shelbourne, New London, Conn.	9½	Sept. 15, 1877	June 30, 1878	1,500 to 2,000	1 clam-shell.
6	American Dredging Company, Philadelphia, Pa.	20	July 16, 1877	Oct. 16, 1877	....	Grapple-dredge.
7	A. J. Dalton, Norfolk, Va...	36	Aug. 16, 1877	Jan. 1, 1878	700	3 dredges.
8	H. E. Culpepper, Portsmouth, Va.	18	July 16, 1877	Feb. 16, 1878		
9	J. H. Fenner, Albany, N. Y.	17	July 15, 1877	July 1, 1878	700 to 800	2 or more dippers.
10	G. H. Ferris, Baltimore, Md	10¼	July 20, 1877	June 30, 1878	800	1 large dipper.
11	Austin P. Brown, Washington, D. C.	18¼	6 weeks after execution of contract	In 8 months.		

The contract was awarded to Mr. Sidney F. Shelbourne, of New London, Conn., who was informed of the fact on the last day of the fiscal year.

It will be seen from an examination of the bids that the lowest and next to the lowest bids are much less than might have been anticipated, on account of the distance and exposed position of the dumping-ground. A large amount of work can be done under the present contract, and, assuming that the same rates will be offered at the next letting, the amount required to complete the work will be less than the original estimate. Upon this assumption, $25,000 will be sufficient to complete the dredging at the mouth of the Eastern Branch of Elizabeth River and to remove any wrecks which are likely to cause objectionable deposits.

In my report of February 15, 1875, the changes which had taken place in the harbor of Norfolk and its approaches were referred to, and a survey was recommended to determine the amount of deterioration and to obtain data for the establishment of port-warden lines. This work has been partly executed by a board of officers appointed at the request of the harbor commissioners. The board have recommended the establishment of port-warden lines, and have submitted a general plan for the improvement of the harbor and its approaches, so as to give a depth of 25 feet at low water as far as the navy-yard.

The dredging recommended by the board in the harbor of Norfolk, exclusive of the approaches, was as follows:

	Cubic yards.
1. On the border of Portsmouth Flats	550,000
2. At the mouth of the Eastern Branch	250,000
3. Between the mouth of the Southern Branch and Berkeley Flats	130,000
Total	930,000

I would state that the second item of the above estimate includes my estimate for the improvement of the harbor, made in the report of February 15, 1875, and the appropriation of August 14, 1876, was for the purpose of executing this work.

In order to carry 25 feet from Hampton Roads up to the city of Norfolk, it will be necessary to dredge the channel between the Hospital light and Sewall's Point, so as to give a width of 400 feet and a low-water depth of 25 feet, which will require the removal of about 1,200,000 cubic yards of material.

As the final recommendations of the board have not yet been made public, it seems proper to defer for the present making any estimate for the general improvement of the harbor and its approaches.

Norfolk is a port of entry. The receipts of customs for the year ending June 30, 1876, were $26,482.90. The business of the city is, however, almost entirely confined to exports and domestic shipments of cotton, naval stores, lumber, breadstuffs, &c.

The following statistics of the trade and shipping are given, in addition to those presented in the report of February 15, 1875:

Foreign-bound clearances.

Year.	No. of bottoms.	Tonnage.
1873	71	30,613
1874	96	51,139
1875	119	53,683
1876	94	65,504
Total	380	200,939

Coastwise clearances.

Year.	Tonnage.	Crew.	No. of bottoms.
1873	1,021,376	29,368	1,072
1874	1,119,029	30,506	1,183
1875	968,271	25,865	1,022
1876	1,104,747	28,800	1,072
Total	4,213,423	114,539	4,349

STATEMENT OF EXPORT VALUES.

1873	$1,267,769
1874	3,906,318
1875	6,243,972
1876	7,825,112
Total	19,243,171

Money statement.

Amount appropriated by act approved August 14, 1876	$35,000 00
July 1, 1877, amount expended during fiscal year	289 15
July 1, 1877, amount available	34,710 85
Amount (estimated) required for completion of existing project	25,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1879.	25,000 00

45TH CONGRESS, 2d Session. } HOUSE OF REPRESENTATIVES. { Ex. Doc. No. 62.

VETO OF THE BILL FOR SPECIAL TERM OF UNITED STATES COURT IN MISSISSIPPI.

MESSAGE

FROM THE

PRESIDENT OF THE UNITED STATES,

ASSIGNING

Reasons for withholding his approval of the bill of the House (H. R. 3072) entitled "An act to authorize a special term of the circuit court of the United States for the southern district of Mississippi, to be held at Scranton, in Jackson County."

MARCH 6, 1878.—Referred to the Committee on the Judiciary and ordered to be printed.

To the House of Representatives:

I return herewith House bill No. 3072, entitled "An act to authorize a special term of the circuit court of the United States for the southern district of Mississippi, to be held at Scranton, in Jackson County," with the following objections to its becoming a law:

The act provides that a special term of the circuit court of the United States for the southern district of Mississippi shall be held at Scranton, in Jackson County, Mississippi, to begin on the second Monday in March, 1878, and directs the clerk of said court to "cause notice of said special term of said court to be published in a newspaper in Jackson, Mississippi, and also in a newspaper in Scranton, at least ten days before the beginning thereof."

The act cannot be executed, inasmuch as there is not sufficient time to give the notice of the holding of the special term, which Congress thought proper to require.

The number of suits to be tried at the special term, in which the United States is interested, is forty-nine, and the amount involved exceeds $200,000. The government cannot prepare for trial at said special term because no fund appropriated by Congress can be made available for that purpose. If, therefore, the government is compelled to go to trial at the special term provided for by this bill the United States must be defeated for want of time and means to make preparation for the proper vindication of its rights.

The bill is therefore returned for the further consideration of Congress.

R. B. HAYES.

EXECUTIVE MANSION, *March* 6, 1878.

I certify that this act originated in the House of Representatives.

Attest:

GEO. M. ADAMS,
Clerk.

AN ACT to authorize a special term of the circuit court of the United States for the southern district of Mississippi to be held at Scranton, in Jackson County.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That a special term of the circuit court of the United States for the southern district of Mississippi shall be holden at Scranton, in Jackson County, Mississippi, to begin on the second Monday in March, eighteen hundred and seventy eight; and the clerk of said court shall cause notice of said special term of said court to be published in a newspaper in Jackson, Mississippi, and also in a newspaper in Scranton, at least ten days before the beginning thereof. And all process, writs, bonds, and recognizances which relate to any suit or suits pending, or which may be instituted in said court in behalf of the United States against any party or parties for or on account of any lumber, logs, charcoal, or turpentine, or growing out of or on account of any alleged depredation upon, or timber cut or taken from, any of the public lands of the United States in said district shall be considered as belonging to such special term; and such suits shall be then and there tried and determined as if they had been brought, and such writs, process, bonds, and recognizances had been opened and taken with reference and made returnable to such special term. And the presiding judge of said court shall have power to continue such special term from time to time until said suits shall be determined, if, in his judgment, the ends of justice may so require.

SAM. J. RANDALL,
Speaker of the House of Representatives.
W. A. WHEELER,
Vice-President of the United States and President of the Senate.

45TH CONGRESS, 2d Session. } HOUSE OF REPRESENTATIVES. { Ex. Doc. No. 63.

SALE OF UNITED STATES BONDS FOR OUTSTANDING LEGAL-TENDER NOTES.

LETTER

FROM

THE SECRETARY OF THE TREASURY,

IN ANSWER TO

A resolution of the House of Representatives, in reference to the sale of United States bonds for outstanding legal-tender notes.

MARCH 7, 1878.—Referred to the Committee on Banking and Currency and ordered to be printed.

TREASURY DEPARTMENT, *March* 7, 1878.

SIR: In response to a resolution offered by Mr. Bright, which requests the Secretary of the Treasury to inform the House of Representatives of the Congress of the United States whether he has "authorized the sale of any of the bonds of the United States for the outstanding legal-tender notes of the United States, at par, adding the current New York premium on gold and commission for selling; or whether he has authorized the sale of such bonds for legal-tender notes upon any other terms than the above stated, and, if so, what is the number and the amount of the proceeds of such bonds," &c., I have the honor to state that all bonds disposed of by me have been sold for their par value in coin, as provided by the authorizing act of July 14, 1870.

To promote the convenience of subscribers, the department has made arrangements with the National Bank of Commerce of New York (a public depositary), whereby currency-drafts can be received from subscribers and collected and converted into coin for them at current rates on the day of the transaction, and such collections and conversions have been made to the extent of about $50,000, representing thirty-five subscriptions.

Very respectfully,

JOHN SHERMAN,
Secretary.

Hon. SAMUEL J. RANDALL,
Speaker House of Representatives.

IMPROVEMENT OF SOUTHWEST PASS OF THE MISSISSIPPI RIVER.

LETTER

FROM

THE SECRETARY OF WAR,

TRANSMITTING

Report of engineer upon the improvement of the Southwest Pass of Mississippi River.

MARCH 8, 1878.—Referred to the Committee on Commerce and ordered to be printed.

WAR DEPARTMENT,
Washington City, March 8, 1878.

SIR: The Secretary of War has the honor to transmit to the House of Representatives, for the Committee on Commerce, a letter of the 6th instant from the Chief of Engineers, in reply to the request of the chairman of said committee for information as to the necessity for continuing, in the river and harbor bill, the appropriation for the improvement of the Southwest Pass at the mouth of the Mississippi River.

GEO. W. MCCRARY,
Secretary of War.

To the SPEAKER
of the House of Representatives.

OFFICE OF THE CHIEF OF ENGINEERS,
Washington, D. C., March 6, 1878.

SIR: In answer to the letter of the 25th ultimo, from Hon. Mr. Reagan, chairman Committee on Commerce, House of Representatives, and in explanation of the estimates submitted from this office for continuing the improvement of Southwest Pass, Mississippi River, I would state that at the time the officer in charge of that work made the estimates upon which those of this office for the next fiscal year were based, a clear channel of 18 feet had not been attained through the South Pass, which was the condition upon which, by the act of August 14, 1876, work at the Southwest Pass was to be suspended.

Under present conditions this item should, for the time, be omitted, although a sum of $10,000 ought to be made available under the same head of appropriation for the care and preservation of the public prop-

erty belonging to this improvement, as well as to meet any contingency that may arise requiring an examination of the changes that may take place at Southwest Pass.

The letter of Hon. Mr. Reagan is herewith returned.

Very respectfully, your obedient servant,

A. A. HUMPHREYS,
Brigadier-General and Chief of Engineers.

Hon. GEO. W. MCCRARY,
Secretary of War.

FEES OF CUSTOMS OFFICERS.

LETTER

FROM

THE SECRETARY OF THE TREASURY,

TRANSMITTING

A statement of emoluments and fees of customs officers.

MARCH 11, 1878.—Referred to the Committee of Ways and Means and ordered to be printed.

TREASURY DEPARTMENT, *March* 8, 1878.

SIR: I have the honor to transmit herewith a statement of the official emoluments and fees received by customs officers during the fiscal year ending June 30, 1877, prepared in the office of the Commissioner of Customs, in accordance with the requirements of section 2639 of the Revised Statutes.

Very respectfully,

JOHN SHERMAN, *Secretary.*

Hon. SAMUEL J. RANDALL,
Speaker House of Representatives.

COLLECTORS OF CUSTOMS AND SURVEYORS OF CUSTOMS ACTING AS COLLECTORS.

Statement of the official emoluments of officers of the customs for the fiscal year ending June 30, 1877. (Required by section 2639, Revised Statutes.)

Name of officer and district or port.	Receipts.							Expenditures.					
	Balance due United States July 1, 1876.	Salary.	Fees.	Commissions.	Storage.	Advances.	Balance due officer June 30, 1877.	Balance due officer July 1, 1876.	Deputies and clerks.	Other expenses.	Compensation.	Deposits.	Balance due United States June 30, 1876.
Adrian Vandine, Aroostook, Me	$308 11	$1,000 00	$327 65	$175 73							$1,500 00		$311 49
E. T. Fox, Bangor, Me			1,516 39	202 93		$1,450 0			$1,450 00	$36 42	1,682 90		
E. S. J. Nealley, Bath, Me			2,245 64	353 93	$72 50						2,672 11		
W. C. Marshall, Belfast, Me. *a*			1,103 77	255 59	179 96	19 53			19 53		1,539 32		
W. H. Sargent, Castine, Me													
John D. Hopkins, Frenchman's Bay, Me		150 00	802 14	18 63	368 00	1,212 00			1,212 00		1,338 77		
J. W. Sargent, Kennebunk, Me			213 70	31 89		600 00			600 00		245 59		
George Leavitt, Machias, Me		250 00	1,537 56	33 38							1,820 94		
Noel B. Nutt, Passamaquoddy, Me	3,177 74	500 00	5,000 33	1,229 14		900 00			3,595 00		3,000 00		4,212 21
Israel Washburn, jr., Portland and Falmouth, Me		4,994 50									4,994 50		
Lot M. Morrill, Portland and Falmouth, Me		1,005 50									1,005 50		
Moses Lowell, Saco, Me		250 00	52 75	1 84		675 00			675 00		304 59		
James A. Hall, Waldoborough, Me		250 00	1,549 1[illegible]	47 77							1,846 90		
Orrin McFadden, Wiscasset, Me		200 00	774 62	62 68							1,037 30		
E. A. Bragdon, York, Me		250 00	8 00	43							258 43		
Alfred F. Howard, Portsmouth, N. H. *b*			638 95	309 61							948 56		
William Wells, Vermont, Vt		1,000 00	20,644 86	15,035 66		21,240 82		$1,424 74	36,985 68		2,500 00		16,980 92
C. F. Swift, Barnstable, Mass. *c*			42 50								42 50		
F. B. Goss, Barnstable, Mass. *d*			1,956 10	101 00	900 35	1,395 00			1,395 00		2,957 45		
William A. Simmons, Boston and Charlestown, Mass		8,000 00									8,000 00		
C. B. Marchant, Edgartown, Mass		250 0	634 52	61 63		1,895 00			1,895 00	40 00	906 15		
James Brady, jr., Fall River, Mass	271 64	150 00	703 30	215 21							1,068 51		274 64
F. J. Babson, Gloucester, Mass	4 71	85 3[illegible]	4,006 9[illegible]	198 24	1,136 00	2,075 00			3,100 00		4,136 00		270 29
Simeon Dodge, Marblehead, Mass			299 20	27 32							326 52		
Wm. P. Hiller, Nantucket, Mass		85 45	17 15	1 97		1,250 00			1,250 00		104 54		
J. A. P. Allen, New Bedford, Mass			1,516 5[illegible]	247 35		2,860 00			2,860 00		1,763 92		

W. H. Huse, Newburyport, Mass	731 76		557 46	2,683 61	177 00						3,177 00		972 83
Thomas Loring, Plymouth, Mass		51 25	152 05	508 03		800 00			800 00	23 74	687 59		
Charles H. Odell, Salem and Beverly, Mass			587 46	51 50	27 60	1,600 00			1,600 00		666 55		
A. S. De Wolf, Bristol and Warren, R. I			40 30	1 19		550 00			550 00		41 49		
Seth W. Macy, Newport, R. I			684 84	16 81		1,000 00			1,000 00		701 65		
James Shaw, jr., Providence, R. I			2,314 00	1,952 14	190 84	1,274 61	$15 24		2,115 00		3,990 84	$440 99	
J. S. Hanover, Fairfield, Conn		250 00	883 29	53 13		1,200 00			1,200 00		1,186 42		
Aug. Putnam, Middletown, Conn			841 40	264 58	100 00	2,280 43			2,280 43		1,205 98		
Cyrus Northrop, New Haven, Conn	3,472 51		1,962 60	7,386 60	175 00				3,400 00		3,175 00	5,612 51	809 20
George T. Marshall, New London, Conn. *e*	481 88		1,109 28	832 31	10 00	1,200 00			1,200 00		1,951 59	481 88	
John A. Tibbitts, New London, Conn. *f*			368 39	598 43		400 00			400 00		626 38		340 44
Geo. Hubbard, Stonington, Conn. *g*		150 00	439 60	21 05		600 00			600 00		610 65		
J. C. Whitney, Albany, N. Y	96 84	600 00	881 10	3,127 68		200 00					4,608 78		296 84
R. W. Daniels, Buffalo Creek, N. Y. *h*	17,153 03	716 67	8,836 10	6,938 63	286 00				8,171 34	6 58	2,077 67	19,301 01	4,373 83
John Tyler, Buffalo Creek, N. Y. *i*		283 33	3,106 85	2,076 03					3,806 50	5 85	708 33		945 53
Sidney Cooper, Cape Vincent, N. Y	305 17	1,000 00	1,810 25	699 59		7,295 39			8,550 02		2,500 00		60 38
S. Moffitt, Champlain, N. Y	958 85	1,000 00	5,869 85	4,529 97					5,374 72		2,500 00	4,483 95	
P. P. Kidder, Dunkirk, N. Y		1,000 00	90 60	7 38		678 84			678 84		1,097 98		
D. K. Cartter, Genesee, N. Y		1,000 00	1,271 40	1,923 28		4,894 84	157 15		5,000 00		2,500 00	1,746 67	
C. A. Arthur, New York, N. Y		12,000 00									12,000 00		
T. E. Ellsworth, Niagara, N. Y	13,272 42	1,000 00	9,692 35	6,693 78					8,600 00		2,500 00	13,272 42	6,286 13
S. P. Remington, Oswegatchie, N. Y		1,000 00	3,075 60	2,673 72	54 00	7,911 55		30	12,160 00		2,554 00		57
Elias Root, Oswego, N. Y	5,385 09	1,000 00	4,778 55	13,214 74	2,000 00	5,967 11			8,138 09		4,500 00	5,086 38	14,621 02
W. S. Havens, Sag Harbor, N. Y		400 00	65 10	15 86		480 00			480 00		480 96		
J. H. Elmer, Bridgetown, N. J		250 00	348 40	35 75							634 15		
W. S. Ashmore, Burlington, N. J		150 00	63 80	4 04							217 84		
I. S. Adams, Great Egg Harbor, N. J		250 00	260 84	18 61		730 00			730 00		529 45		
J. H. Bartlett, Little Egg Harbor, N. J		250 00	82 50								332 50		
W. A. Baldwin, Newark, N. J		250 00	638 87	63 15		1,200 00			1,200 00		952 02		
C. H. Houghton, Perth Amboy, N. J		250 00	882 30		45 47	1,223 56			1,200 00	23 56	1,177 77		
A. P. Tutton, Philadelphia, Pa		8,000 00									8,000 00		
Thomas Steel, Pittsburgh, Pa. *j*	2,343 15	229 21	503 87	1,456 04		567 42			567 42		2,189 12		2,343 15
J. S. Rutan, Pittsburgh, Pa. *k*		208 29	1,355 45	986 07		2,603 12			2,596 60		2,549 81		6 52
J. R. Willard, Erie, Pa	1,878 75	1,000 00	698 75	1,097 67		404 14			700 00		2,500 00	1,878 75	56
L. Thompson, Delaware, Del		500 00	531 62	240 98		1,600 00			1,600 00		1,272 60		
J. G. Taylor, Annapolis, Md		250 00	298 55	78 99		550 00			550 00		627 54		
Wash. Booth, Baltimore, Md. *l*		913 07									913 07		
Ed. Wilkins, Baltimore, Md. *m*		6,086 90									6,086 90		
T. H. Hodson, Eastern, Md. *n*													

a Adjustment of account suspended.
b $25 compensation in lieu of moieties.
c From July 1 to 7, 1876.
d From July 8, 1876, to June 30, 1877.
e From July 1, 1876, to April 15, 1877.
f From April 16 to June 30, 1877.
g From March 2 to June 30, 1877.
h From July 1, 1876 to March 19, 1877. $41.02 compensation in lieu of moieties.
i From March 20 to June 30, 1874.
j From April 1 to November 26, 1876.
k From November 27, 1876, to June 30, 1877.
l From July 1 to August 17, 1876.
m From August 18, 1876, to June 30, 1877.
n Adjustment of account suspended.

Statement of the official emoluments of officers of the customs for the fiscal year ending June 30, 1877, &c.—Continued.

Name of officer and district or port.	Receipts.							Expenditures.					
	Balance due United States July 1, 1876.	Salary.	Fees.	Commissions.	Storage.	Advances.	Balance due officer June 30, 1877.	Balance due officer July 1, 1876.	Deputies and clerks.	Other expenses.	Compensation.	Deposits.	Balance due United States June 30, 1877.
C. S. English, Georgetown, D. C		$500 00	$731 39	$143 45	$0 30						$1,384 14		
David Turner, Alexandria, Va. *a*			398 09	3 09		$796 70			$796 70		401 18		
A. A. Warfield, Alexandria, Va. *b*			144 05	16 06		403 30			403 30		160 11		
George Toy, Cherrystone, Va		500 00	495 25	22 92		775 30			775 30		1,018 17		
L. Lee, jr., Norfolk and Portsmouth, Va. *c*	$400 00		2,024 45	256 55		2,766 27			3,189 10		1,841 63		$416 54
J. S. Braxton, Norfolk and Portsmouth, Va. *d*			1,547 14	219 61		1,824 40			2,039 20		1,158 30	$388 84	4 81
B. S. Burch, Petersburg, Va			498 00	9 51		1,334 10			1,334 10		507 51		
C. S. Mills, Richmond, Va			1,344 92	355 02		1,507 14			1,507 14		1,699 94		
John T. Haskins, Tappahannock, Va		250 00	168 15	5 46		512 50			512 50		423 61		
J. B. Mitchell, Yorktown, Va		200 00	367 15	16 31		300 00			300 00		583 46		
W. R. Holliday, Wheeling, W. Va. *e*		291 35	738 00	107 63		275 30			963 80		448 48		
James Gilchrist, Wheeling, W. Va. *f*		58 65	473 30	38 80					24 70		502 75		43 39
Alex. C. Davis, Beaufort, N. C		1,000 00	221 45	2 72		300 00			300 00		1,224 17		
Thomas A. Henry, Pamlico, N. C		1,000 00	478 45	113 32		2,230 00			2,230 00		1,591 77		
Charles G. Manning, Albemarle, N. C		1,000 00	172 25	14 22		1,344 00			1,344 00		1,186 47		
James C. Abbott, Wilmington, N. C	1,372 96	1,000 00	2,084 54	1,380 72		3,247 20			3,247 20		2,500 00	707 01	2,631 21
George Gage, Beaufort, S. C		1,000 00	1,410 51	658 16		37 50			37 50		3,000 00		68 67
H. G. Worthington, Charleston, S. C	276 61		4,010 45	536 96	184 00	8,540 40			8,540 40		4,184 00	823 71	31
H. F. Heriot, Georgetown, S. C		250 00	132 12	11 51		600 00			600 00		393 63		
John T. Collins, Brunswick, Ga	31 59	500 00	1,796 87	497 75							2,794 69		31 59
James Atkins, Savannah, Ga. *g*	469 8.		2,507 60	597 67	334 86	9,515 76			9,515 76		3,440 13	469 83	
Joseph Shepard, Saint Mary's, Ga. *h*		62 48	32 61	1 30							96 39		
P. H. Raiford, Saint Mary's, Ga. *i*			229 26									229 26	
Joseph Shepard, Saint Mary's, Ga. *j*		108 10	339 71	58 11		900 00			900 00		558 92		

John C. Goodloe, Mobile, Ala	765 01	250 00	1,594 92	1,555 02	1,269 36	4,400 00	....	....	4,400 00	....	4,269 36	971 04	193 94
Frank Heiderhoff, Pearl River, Ala. k	....	69 29	161 40	16 25	....		....	....	....	....	246 94	....	....
I. N. Osborn, Pearl River, Ala. l	....	99 49	701 68	89 43	....		....	....	....	....	890 60	....	....
W. B. Chandler, Pearl River, Ala. m	....	....	121 85	....	....	....	....	....	....	....	....	121 85	....
H. P. Hurst, Pearl River, Ala. n	....	70 82	385 16	105 95	....	....	....	....	....	....	561 93	....	....
A. M. Hardy, Natchez, Miss. o	....	312 54	70	....	....	....	....	....	....	....	313 24	....	....
E. J. Castello, Natchez, Miss. p	....	....	....	....	....	....	....	....	....	....	....	....	....
P. C. Hall, Vicksburg, Miss	....	500 00	29 20	1 92	....	....	....	....	....	....	531 12	....	....
James F. Casey, New Orleans, La. q	....	6,115 36	....	....	....	....	....	....	....	....	6,115 36	....	....
John E. King, New Orleans, La. r	....	884 59	....	....	....	....	....	....	....	....	884 59	....	....
E. W. Halbrook, Teche, La	....	1,000 00	514 40	25 55	....	....	....	....	....	....	1,539 95	....	....
A. J. Murat, Apalachicola, Fla	....	500 00	83 50	3 55	....	....	....	....	....	....	587 05	....	....
F. E. Grossman, Fernandina, Fla	....	500 00	1,091 14	149 44	....	....	....	....	....	....	1,740 58	....	....
F. N. Wicker, Key West, Fla	3,570 30	500 00	2,541 52	8,203 06	1,095 00	....	....	....	6,911 35	....	4,095 00	....	4,903 59
Hiram Potter, jr., Pensacola, Fla. s	....	832 40	3,158 89	1,382 74	....	64 85	....	....	2,850 00	....	2,497 25	....	91 63
F. C. Humphreys, Pensacola, Fla. t	....	167 60	583 18	172 20	....	447 37	....	....	867 60	....	502 75	....	....
A. J. Goss, Saint Augustine, Fla	....	500 00	88 80	72	....	162 00	....	....	162 00	....	589 52	....	....
John R. Scott, Saint John's, Fla	....	500 00	557 05	32 98	....	730 00	....	....	730 00	....	1,090 03	....	....
W. D. Sears, Saint Mark's, Fla. u	....	280 56	224 40	....	....	....	....	....	....	....	504 96	....	....
J. M. Currie, Saint Mark's, Fla. v	....	219 44	266 71	10 17	....	....	....	....	....	....	496 32	....	....
John L. Haynes, Brazos de Santiago, Tex	....	1,500 00	2,333 15	....	2,000 00	10,504 52	....	....	10,504 52	....	4,500 00	1,133 15	....
Ridge Paschal, Corpus Christi, Tex	....	1,500 00	1,147 40		939 30	854 87	....	....	989 26	....	3,439 30	....	13 01
B. G. Shields, Galveston, Tex	....	1,500 00	2,471 31	....	2,000 00	11,807 10	....	....	11,814 49	....	4,500 00	1,463 92	....
C. Caldwell, Paso del Norte, Tex. w	....	1,895 64	....	....	....	....	....	....	....	....	1,895 64	....	....
S. C. Slade, Paso del Norte, Tex. x	....	104 36	....	....	....	....	....	....	....	....	104 36	....	....
C. R. Prouty, Saluria, Tex	....	1,500 00	866 02	....	....	3,156 64	....	....	3,156 64	....	2,366 02	....	....
James P. Luse, Louisville, Ky. y	1,062 01	280 77	572 35	1,386 55	304 00	2,098 36	....	....	2,098 36	....	2,543 67	408 09	653 92
T. O. Shackelford, Louisville, Ky. z	....	69 23	173 90	225 63	23 60	751 64	....	....	751 64	....	492 36	....	....
Adam Woolf, Nashville, Tenn	....	350 00	140 05	74 60	....	....	....	....	....	....	564 65	....	....
William J. Smith, Memphis, Tenn	....	350 00	304 85	1,011 00	1,500 00	1,000 00	....	....	1,000 00	....	3,165 85	....	....
John F. Long, Saint Louis, Mo	46,480 46	350 00	3,489 35	42,131 02	1,094 75	....	....	....	17,664 73	860 90	5,000 00	44,700 71	26,119 24
P. G. Watmough, Cuyahoga, Ohio aa	6,094 75	868 13	3,033 35	2,439 17	....	1,287 54	....	....	5,434 64	23 16	2,170 33	373 34	5,721 41
Geo. W. Howe, Cuyahoga, Ohio bb	....	131 86	1,138 85	590 84	....	....	....	....	850 34	3 37	329 67	....	608 19
John W. Fuller, Miami, Ohio	1 70	1,000 00	1,791 50	736 98	33 00	1,646 16	....	....	2,400 00	....	2,533 00	276 34	....
John G. Pool, Sandusky, Ohio	....	1,000 00	2,501 11	50 88	....	1,748 31	....	80 30	2,800 00	....	2,500 00	....	....
R. H. Stephenson, Cincinnati, Ohio	....	350 00	1,568 40	7,412 62	212 50	2,742 91	....	224 15	6,978 05	15 45	5,000 00	....	68 78
T. Hornbrook, Evansville, Ind. cc	....	....	....	....	....	....	....	....	....	....	....	....	....
J. C. Jewell, Evansville, Ind. cc	....	....	....	....	....	....	....	....	....	....	....	....	....

a From July 1, 1876, to Feb. 28, 1877.
b From March 1 to June 30, 1877.
c From July 1, 1876, to Feb. 10, 1877.
d From Feb. 11 to June 30, 1877.
e From July 1, 1876, to April 30, 1877.
f From May 1 to June 30, 1877.
g From April 1, 1876, to March 31, 1877.
h From July 1 to Aug. 15, 1876.
i From Aug. 16, 1876, to Feb. 28, 1877.
j From March 1 to June 30, 1877.
k From July 1 to Oct. 10, 1876.
l From Oct. 11, 1876, to March 4, 1877.
m From March 5 to 19, 1877.
n From March 20 to June 30, 1877.
o From July 1, 1876, to Feb. 14, 1877.
p No account received.
q From July 1, 1876, to May 15, 1877.
r From May 16 to June 30, 1877.
s From July 1, 1876, to April 30, 1877.
t From May 1 to June 30, 1877.
u From July 1, 1876, to Jan. 22, 1877.
v From Jan. 23 to June 30, 1877.
w From July 1, 1876, to June 11, 1877.
x From June 12 to 30, 1877.
y From July 1, 1876, to April 19, 1877.
z From April 20 to June 30, 1877.
aa From July 1, 1876, to May 13, 1877.
bb From May 14 to June 30, 1877.
cc No account received.

Statement of the official emoluments of officers of the customs for the fiscal year ending June 30, 1877, *&c.*—Continued.

Name of officer and district or port.	Receipts.							Expenditures.						
	Balance due United States July 1, 1876.	Salary.	Fees.	Commissions.	Storage.	Advances.	Balance due officer June 30, 1877.	Balance due officer July 1, 1876.	Deputies and clerks.	Other expenses.	Compensation.	Deposits.	Balance due United States June 30, 1877.
Digby V. Bell, Detroit, Mich	$1 17	$1,000 00	$14,217 10	$7,117 77	$2,000 00	$3,675 65			$22,269 10		$4,500 00	$1,235 29	$7 30
John P. Sanborn, Huron, Mich	1,652 29	1,000 00	9,435 40	4,641 00		4,361 25			13,168 62	$582 69	2,500 00	1,652 29	3,186 34
H. C. Akeley, Michigan, Mich		1,000 00	8,011 10	101 72				$5 00	4,115 83		2,500 00	1,231 87	1,260 12
J. H. Chandler, Superior, Mich	801 43	1,000 00	2,787 20	152 81		4,182 77			6,424 21		2,500 00		
J. R. Jones, Chicago, Ill		1,000 00	14,721 95	41,395 66	2,000 00			32	29,473 75	57 43	4,500 00	10,000 00	15,086 11
Daniel Wann, Galena, Ill		350 00	150 60	21 97		500 00			500 00		592 57		
George Fisher, Cairo, Ill		800 00	107 95	8 53		600 00			600 00		916 48		
J. C. Abercrombie, Burlington, Iowa		350 00	52 45	9 37							411 82		
Deloss E. Lyon, Dubuque, Iowa		350 00	127 90	15 80							493 70		
Geo. C. Stevens, Milwaukee, Wis	95 77											95 77	
John Nazro, Milwaukee, Wis		1,000 00	4,769 05	1,744 03	61 20	367 85			4,660 00		2,561 20		713 93
Isaac H. Moulton, La Crosse, Wis		1,200 00									1,200 00		
Henry Selby, Duluth, Minn *a*		29 89	115 15	40	33 00				68 87		107 73	1 84	
Vespasian Smith, Duluth, Minn *b*		970 11	2,442 35	53 61	654 00	998 97			1,500 12		3,079 27		449 65
J. Frankenfield, Minnesota, Minn		1,000 00	1,567 72	319 30				14 93			2,500 00	99 36	272 73
Thos. B. Shannon, San Francisco, Cal		7,000 00									7,000 00		
W. W. Bowers, San Diego, Cal		3,000 00									3,000 00		
W. D. Hare, Oregon, Oreg		3,000 00									3,000 00		
Samuel Hannah, Willamette, Oreg *c*	63 73	143 98	187 30	1,572 54	100 00						532 05		1,535 50
John Kelly, Willamette, Oreg *d*		856 02	1,178 25	2,290 60	1,027 16	5,043 40			6,666 70		3,595 11	96 32	567 30
David L. Watson, southern district, Oregon		1,000 00	46 75	1 68							1,048 43		
H. A. Webster, Puget Sound, W. T.	784 72	1,000 00	3,473 05	568 39		2,258 56			4,300 00	318 42	3,000 00	14 75	451 55
W. W. Copeland, Omaha, Nebr		350 00	77 30	37 02							464 32		
Thomas A. Cummings, Montana and Idaho		1,000 00	34 90	170 90		450 00			450 00		1,205 80		
M. P. Berry, Alaska		2,500 00	1,114 80	40 37							3,655 17		
Aggregate	113,769 07	123,199 28	281,261 24	212,431 95	23,397 75	185,833 95	$172 39	1,669 74	355,497 73	1,197 59	284,487 06	118,909 14	118,207 31

a From July 1 to 11, 1876. *b* From July 12, 1876, to June 30, 1877. *c* From July 1 to Aug. 22, 1876. *d* From Aug. 23, 1876, to June 30, 1877.

RECAPITULATION.

Balance due United States July 1, 1876	$113,769 07
Salary	123,192 22
Fees	221,261 24
Commissions	212,431 95
Storage	23,397 75
Advances	185,833 95
Balance due officer June 30, 1877	172 39
	880,058 57

Contra.

Balance due officer July 1, 1876	$1,669 74
Deputies and clerks	355,497 73
Other expenses	1,197 59
Compensation	284,487 06
Deposits	118,999 14
Balance due United States June 30, 1877	118,207 31
	880,058 57

TREASURY DEPARTMENT, OFFICE OF COMMISSIONER OF CUSTOMS, *March* 4, 1878.

H. C. JOHNSON,
Commissioner of Customs.

NAVAL OFFICERS.

Statement of the official emoluments of officers of the customs for the fiscal year ending June 30, 1877, *&c.*—Continued.

Name of officer and district or port.	Receipts.							Expenditures.					
	Balance due United States July 1, 1877.	Salary.	Fees.	Commissions.	Storage.	Advances.	Balance due officer June 30, 1877.	Balance due officer July 1, 1876.	Deputies and clerks.	Other expenses.	Compensation.	Deposits.	Balance due United States June 30, 1877.
Walter Harriman, Boston and Charlestown, Mass. *a*	....	$4,903 31	....	....	....	....	....	....	....	....	$4,903 31	....	....
Daniel Hall, Boston and Charlestown, Mass. *b*	....	796 72	....	....	....	....	....	....	....	....	796 72	....	....
Addison H. Laflin, New York, N. Y. *c*	....	4,688 90	....	....	....	....	....	....	....	....	4,688 90	....	....
Alonzo B. Cornell, New York, N. Y. *d*	....	3,311 10	....	....	....	....	....	....	....	....	3,311 10	....	....
John A. Hiestand, Philadelphia, Pa	....	5,000 00	....	....	....	....	....	....	....	....	5,000 00	....	....
Adam E. King, Baltimore, Md	$11 00	....	$3,728 77	....	....	$14,965 17	....	....	$14,965 17	$11 00	5,000 00	$3,728 77	....
C. Dillingham, New Orleans, La. *e*	919 84	....	234 40	....	....	1,223 00	....	....	2,069 83	....	234 40	22 08	50 93
A. F. Biard, New Orleans, La. *f*	....	....	5,287 11	....	....	13,617 00	....	....	13,943 10	....	4,714 67	246 34	....
Edwin G. Waite, San Francisco, Cal	....	5,000 00	....	....	....	....	....	....	....	....	5,000 00	....	....
Aggregate	930 84	23,000 03	14,250 28	....	....	29,805 17	....	....	30,978 10	11 00	32,949 10	3,997 19	50 93

a From July 1, 1876, to May 3, 1877.
b From May 4 to June 30, 1877.
c From July 1, 1876, to Jan. 31, 1877.
d From Feb. 1 to June 30, 1877.
e From July 1 to 21, 1876.
f From July 22, 1876, to June 30, 1877.

RECAPITULATION.

		Contra.	
Balance due United States July 1, 1876	$930 84	Balance due officer July 1, 1876	
Salary	23,000 03	Deputies and clerks	$30,978 10
Fees	14,250 28	Other expenses	11 00
Commissions		Compensation	32,949 10
Storage		Deposits	3,997 19
Advances	29,805 17	Balance due United States June 30, 1877	50 93
Balance due officer June 30, 1877			
	67,986 32		67,986 32

TREASURY DEPARTMENT, OFFICE OF COMMISSIONER OF CUSTOMS, *March* 4, 1878

H. C. JOHNSON,
Commissioner of Customs.

SURVEYORS OF CUSTOMS.

Statement of the official emoluments of officers of the customs for the fiscal year ending June 30, 1877, &c.—Continued.

Name of officer and district or port.	Receipts.							Expenditures.					
	Balance due United States July 1, 1876.	Salary.	Fees.	Commissions.	Storage.	Advances.	Balance due officer June 30, 1877.	Balance due officer July 1, 1876.	Deputies and clerks.	Other expenses.	Compensation.	Deposits.	Balance due United States June 30, 1877.
Jas. M. Livermore, Eastport, Me		$500 00	$997 55							$29 00	$1,468 55		
George W. True, Portland, Me		150 00	3,804 82			$2,500 00			$2,500 00		3,954 82		
A. B. Underwood, Boston, Mass		5,000 00									5,000 00		
Geo. H. Sharpe, New York, N. Y		8,000 00									8,000 00		
Ed. T. Moore, Patchogue, N. Y			367 25								367 25		
Frank P. Norton, Port Jefferson, N. Y			299 25								299 25		
William Z. King, Greenport, N. Y			342 34								342 34		
E. O. M. Goodrich, Philadelphia, Pa		5,000 00									5,000 00		
Charles Gilpin, Baltimore, Md	$27 41		4,083 79			6,358 20			6,358 20		4,083 79		$27 41
David Porter, Savannah, Ga. *a*													
J. Madison Wells, New Orleans, La	407 45		2,498 34			6,240 00			6,540 00		2,498 34		107 45
J. M. Brougham, Velasco, Tex. *b*		250 00									250 00		
W. S. Chichester, La Vacca, Tex		600 00									600 00		
Thomas Jernegan, Michigan City, Ind		350 00									350 00		
Giles H. Gray, San Francisco, Cal. *c*		3,804 95									3,804 95		
Paul Merrill, San Francisco, Cal. *d*		1,195 05									1,195 05		
Aggregate	434 86	24,850 00	12,393 34			15,098 20			15,398 20	29 00	37,214 34		134 86

a Adjustment of account suspended. *b* Discontinued Sept. 30, 1876. *c* July 1, 1876, to April 4, 1877. *d* April 5 to June 30, 1877.

RECAPITULATION.

		Contra.	
Balance due United States July 1, 1876	$434 86	Balance due officer July 1, 1876	
Salary	24, 850 00	Deputies and clerks	$15, 398 20
Fees	12, 393 34	Other expenses	29 00
Commissions		Compensation	37, 214 34
Storage		Deposits	
Advances	15, 098 20	Balance due United States June 30, 1877	134 86
Balance due officer June 30, 1877			
	52, 776 40		52, 776 40

TREASURY DEPARTMENT, OFFICE OF COMMISSIONER OF CUSTOMS, *March* 4, 1878.

H. C. JOHNSON,
Commissioner of Customs.

O

LINES OF COMMUNICATION BETWEEN COLORADO AND NEW MEXICO.

LETTER

FROM

THE SECRETARY OF WAR,

TRANSMITTING

Reports on lines of communication between Colorado and New Mexico.

MARCH 9, 1878.—Referred to the Committee on Appropriations and ordered to be printed.

WAR DEPARTMENT,
March 8, 1878.

The Secretary of War has the honor to transmit to the House of Representatives copies of report on existing and required lines of communication between Southern Colorado and Northern New Mexico, with maps; also, report and maps of the San Juan reconniassance in 1877.

The commanding general Department of the Missouri forwards these papers with the following remarks:

Garland will undoubtedly be the shipping point, for some years, of all freight destined for Southwestern Colorado, Eastern Arizona, and the whole of New Mexico, excepting only the posts of Union and Stanton; freight rates from Garland, as will be seen, being much below any others offered.

From Garland depart three routes for this service—one to San Juan country, one to the posts in Arizona, including Fort Wingate, New Mexico, and one via Santa Fé to the Lower Rio Grande.

The amount required on each of these roads to make good roads, and thereby still further cheapen freights and facilitate communication, is as follows, viz:

To San Juan country and site of the military post in that region, to which Fort Garland is to be transferred	$11,517 00
To Fort Wingate and posts in Arizona north of Gila River	2,485 00
To Santa Fé	10,000 00
Total	24,002 00

With this small amount these roads can be put in excellent condition; and there is no doubt that the whole sum will be repaid twice over in a few years by reduction of freight-rates. I respectfully ask that the Secretary of War ask a special appropriation for this work, of the amount specified, the work to be done under the charge of Lieutenant Ruffner, chief engineer of this department. The sooner it can be done, the better for the government and all concerned.

The great importance of the roads in the settlement and development of the regions which they traverse need not be set forth. It will suffice to say that in my opinion every interest of the government in that section of country will be greatly benefited at very small expense in this direction.

The General of the Army approves this recommendation, and says:

The completion of the railroad across the Sangre de Cristo Mountains into the valley of the Rio Grande opens up a most interesting and extensive new country. Twenty-four thousand dollars could not be better expended than on the roads herein described, and Captain Ruffner is peculiarly qualified for the work.

An appropriation of $24,000 for this work is accordingly recommended.

GEO. W. McCRARY,
Secretary of War.

The SPEAKER
of the House of Representatives.

COPIES OF PEPORTS ON EXISTING AND REQUIRED LINES OF COMMUNICATION BETWEEN SOUTHERN COLORADO AND NORTHERN NEW MEXICO, WITH MAPS. ALSO, REPORT AND MAP OF THE SAN JUAN RECONNAISSANCE, 1877.

Official copies.

E. D. TOWNSEND,
Adjutant-General.

WAR DEPARTMENT, ADJUTANT-GENERAL'S OFFICE,
Washington, March 6, 1878.

HEADQUARTERS DEPARTMENT OF THE MISSOURI,
OFFICE OF THE CHIEF ENGINEER,
Fort Leavenworth, Kans., January 31, 1878.

SIR: Since writing to you under date of January 11, 1878, relative to existing and required lines of communication between Southern Colorado and Northern New Mexico, the contracts for wagon-transportation from the railroad termini in Colorado to points in New Mexico and Arizona have been let for the present year, and these contracts show a saving in actual cost to the government in favor of Garland, Colo., over El Moro, per 100 pounds for the whole distance, of 22 cents to 59 cents for the Southern New Mexico posts, of 21 cents for Camp Apache, Ariz., and for Fort Wingate the bids are 2 cents greater. The total amount of freight transported annually to these posts is nearly 2,000,000 pounds. The government is therefore already benefited by the extension of the railroad to Garland during the past year at least $2,000, and at most $12,000; probably about $6,000. Rates to Wingate and Camp Apache, in Arizona, are somewhat improved, and will be more so in case the improvements recommended in my paper are made.

Inasmuch as it is now settled that Garland will be the shipping point to posts in Southern and West New Mexico, Eastern Arizona, and as the populated districts in the San Juan region require additional military protection, and therefore facility of communication, a general summary of the needs may be given thus:

Santa Fé and thence to Southern New Mexico:		
Improvement of existing road (estimate)		$10,340
In case Army-ration may be sold to laborers	$6,900	
Southwest to Fort Wingate and Arizona:		
Improvement of road from Puerco Station to Chama Crossing	1,482	1,485
Survey of line down the Puerco River to Rio Grande	1,000	1,000

West of San Juan country:		
Proposed Chama-Navajo road (estimate)		$9,775
In case Army-ration may be sold to laborers	$6,517	
For general use in roads in Southwest Colorado and Northern New Mexico		5,000
In case Army-ration may be sold to laborers	3,500	
Total	19,402	27,600

The needs for these various items have been fully set forth in the previous portions of the report.

The especial value of the first item is manifest when greater freighting is expected to be done over the line.

The call for the Chama-Navajo line is apparent when it is known that its construction will save 37.3 miles to a district that is constantly urging the propriety of building a military post in that vicinity.

The table of population here offered has just been prepared, and throws additional light on this matter. The towns in italics are concerned in the construction of this road.

MAIN POPULATED DISTRICTS, 1877.

	Population.
Conejos and neighboring plazas (Mexican)	2,390
Tierra Amarilla plazas (American, 50; Mexican, 800)	850
Settlers on Rio de Lospinos	80
Animas City and vicinity	450
Parrott City (registered voters 61)	125
Hermosa	60
Silverton (registered voters 250)	700
Adjoining mining camps (registered voters 150)	400
Lake City (registered voters 800)	2,000
Adjoining mining camps and towns	700
Ouray	700
Adjoining mining camps	300
Del Norte (registered voters 500)	1,500
The Summit	125

I am, sir, very respectfully, your obedient servant,

E. H. RUFFNER,
First Lieutenant Engineers.

The ASSISTANT ADJUTANT-GENERAL,
Department of the Missouri.

HEADQUARTERS DEPARTMENT OF THE MISSOURI,
OFFICE OF THE CHIEF ENGINEER,
Fort Leavenworth, Kans., January 11, 1878.

SIR: I have the honor to forward herewith a report on lines of communication between Northern New Mexico and Southern Colorado, accompanied by a map. This report has been prepared in obedience to verbal instructions of the department commander.

Very respectfully, your obedient servant,

E. H. RUFFNER,
First Lieutenant Engineers.

The ASSISTANT ADJUTANT-GENERAL,
Department of the Missouri.

HEADQUARTERS DEPARTMENT OF THE MISSOURI,
OFFICE OF THE CHIEF ENGINEER,
Fort Leavenworth, Kans., January 9, 1878.

SIR: I had the honor to render you a report under date of January 28, 1876, on lines of communication between Southern Colorado and Northern New Mexico.

This report was published, together with the map also submitted at the same time, as Ex. Doc. No. 172, Forty-fourth Congress, first session.

Since that time the railroad extensions, foretold in that paper, have been made and the reasons there given for asking for appropriations to complete and construct certain military wagon-roads still remain and are more permanent.

With a view of refreshing your memory upon this subject and to describe the present state of these lines of communication and the needs of new ones, I now submit a report upon this subject and a map showing the country and roads in question.

The present railroad termini are El Moro, near Trinidad, and Garland City, near Fort Garland, all in Colorado.

From these two points I will describe the

EXISTING LINES OF COMMUNICATION.

From El Moro to the south the conditions are favorable to freighting. The grades are very good with the exception of the passage of the Raton Mountains, which now, in the long, easy slope of the customary route, present no serious obstacle.

The grass and water are ample in quantity and good in quality. Delays occur frequently from incidents of the weather—unusual snows at times, heavy rains in the rainy season, or protracted drought at other periods. Still, these delays do not seriously embarrass trade nor extend over many days at a time. The altitude of the highest point, the Raton Pass, is not great enough to make any practical difference in winter or early spring between this and other portions of the road; and in fact the uniformly high altitude of the whole area in question renders the climate more dependent upon this condition than on the element of latitude, and if the route is in good condition in one portion it is apt to be so in all. In the rainy season storms sometimes cause the streams to rise so as to be impassable, but this is exceptional, and the delay is rarely more than a day or two, or long enough for the water to run out. The most important of these streams are bridged. A daily line of stages runs from Pueblo and West Las Animas, joining at Trinidad, via Fort Union and Las Vegas, to Santa Fé.

From south point Sangre de Cristo range to the Rio Grande.—The next section of the route to be described is that embracing the various roads passing from the east slope of the mountains to the valley of the Rio Grande. Of these, the most northerly is that up the valley of the Pecos River, and thence, via Santa Fé, to Peña Blanca, on the Rio Grande.

The most southerly pass is via Anton Chico and the cañon Blanco to Albuquerque, and is, perhaps, thirty miles farther south. The character of the country now becomes different from that previously encountered. The smooth roads of the prairie are replaced by rocky hills at times, and at others sandstone strata nearly horizontal in position make the road difficult and the grass scanty. The cañons and sandy or gravelly ridges of the elevated plateau upon which Santa Fé is situated are succeeded by the sandy valley of the Rio Grande, and throughout the whole region the abundant grasses of the eastern front of the mountains

are succeeded by a scanty growth, which a delayed rainy season will almost cause to disappear. In the cañons of the more northerly route the snows of a late spring sometimes cover the grazing pastures to such an extent that the starving cattle of the freight-trains, dependent entirely upon this fortuitous grazing, can hardly drag light loads over the heavy roads. Although the main chain of lofty mountains abruptly breaks down in the vicinity of Santa Fé, still the plateau itself maintains its high altitude, and is nowhere lower than 6,000 feet, continuing in a southwest direction until south of Albuquerque, when high mountains again appear. Isolated masses like the Placeres and the Sandia Mountains form obstacles which are avoided only by following down the cañons which seam their sides. From this plateau to the valley of the Rio Grande, by all the routes, necessitates a descent of 1,500 feet in from ten to eighteen miles. The greater portion of this fall is by one road concentrated in one tremendous hill at La Bajada. The ascent to this plateau from the east is fortunately more gradual, and from Anton Chico, which has about the same elevation as the Rio Grande at Peña Blanca, from thirty to forty miles may be given as occupied in the rise. The valley of the Rio Grande is fortunate only in the abundance of good water. The universal occupation of tillable ground by a crowded population allows no pasturage that is not already overstocked, and the sandy mesas furnish a scant substitute, which is only too kindly described as "poor." The roads are good in some places, but are more often sandy. The only route, however, in which the valley of the Rio Grande is followed for any distance is in going from Santa Fé via Algodones and Albuquerque, where twenty-three miles are located in the valley.

From the Rio Grande to Fort Wingate.—From the Rio Grande to Fort Wingate two routes are followed: the lower, via Albuquerque, one hundred and twenty-four miles; the upper, to the west from Peña Blanca, one hundred and fifty miles.

The latter, passing through the rolling foot-hills of the Valles and Jemez Mountains, and across the shattered remnants of the extremity of the lava-field of the Rio Grande, is tedious with sand, and broken with low gravel-hills as far as the Jemez River, at San Ysidro. Scanty grass is the rule, and there is no water between the Rio Grande and the Jemez.

After leaving this portion the road improves, and, although rolling and broken, the lava formation of the first few miles no longer appears, and the absence is not a loss.

At the Rio Puerco the new or proposed route comes in from the north, and from this point to Fort Wingate the two coincide. Water can be found every twelve to eighteen miles; the grazing improves in quality and quantity as one goes farther west; and the road is fair—never very good, never very bad—with sand and clay. The lower route meets the same obstacle after crossing the Rio Grande. Heavy sand-hills and a desolate rolling country separate the dry bed of the Puerco from the Great River of the North. Upon reaching the bed of the San José a good road is met. Gypsum disappears, muddy pools become a running stream, and there are agricultural spots. At Blue Water, thirty-eight miles to the east of Fort Wingate, the other route is joined. These two lines deviate from a direct line in order to pass the imposing mass of Mount Taylor, and one passes to the north as much as the other to the south. This huge peak rears its lofty form, superb in grandeur and regal in its isolation. Scarred volcanic rocks drift down its sides and are lost in its vastness. Its huge base of thirty miles in length and fifteen in width forms a worthy foundation to the structure, piercing to the skies. Easily seen from Santa Fé, one hundred miles to the east, it

is the monarch of these desolate, weather-worn, and wasted lands. Sandstone mesas, water-washed, reach out from the mountain's skirts and repel approach.

Over both routes freighting can be done, and easily; but the difference between the "plains" and these barren mesa-lands, with their scattered pools of water and scant grass, is very great. Over the upper road a regular mail-route has recently been established, a buckboard going twice a week from Santa Fé to Fort Wingate and returning.

Although freighting and, indeed, communication of every kind has heretofore passed from the east to Fort Wingate by the route just described, almost exclusively, still it is not the only way in which it might be done. In lieu of making the detour around the Santa Fé end of the mountains, they may be crossed to the north and the road correspondingly shortened. As will be shown, there was good reason why this was avoided until very recently, and for further reasons it will always be accompanied with objections unless natural obstacles are converted into aids.

By Fort Garland and the west of the mountains to Santa Fé.—Wagon communication between Pueblo and Santa Fé, by the western side of the Sangre de Cristo range, has been possible for many years. It has always been very difficult until recently; but with the completion of the military road from Santa Fé to Taos, a great improvement has been made.

The recent extension of the Denver and Rio Grande Railroad to Garland City has materially altered freighting conditions, as will be shown hereafter.

From Fort Garland to the west and north, through the San Luis Park, fifty-five miles of natural road from the commencement of the route to the San Juan mining district; thirty-eight miles to the southwest, over an excellent natural road, excepting only the crossing of the Rio Grande, forms the first section of the proposed route to Fort Wingate and Arizona; fifty-five miles to the south, over the same excellent and leval road furnished by the San Louis Park, will bring us to the Rio Colorado on our way to Santa Fé; a fine grazing country, with abundance of mountain-streams. The only drawback is, perhaps, that the number of cattle on the range is too great, and the pastures are overstocked.

We now commence to cross the foot-hills, which reach out to the river, or near it, and the park is left with many feelings of regret and longing for its beautiful roads.

Rio Colorado to Taos.—From the Rio Colorado to Taos about twenty-five miles of bad road is encountered, steep hills, up and down which the road must go. The soil is good, and grazing abundant, and water is found almost anywhere.

The pine forests of the mountains come down over these foot-hills, and there is a surprising quantity of fine timber. The valleys of the streams are found in cañons, and the lava-field of the Rio Grande has spurs stretching up these cañons, to the permanent ruin of all roads found therein. In order to make this section of the road really safely passable, work must be done between the Rio Colorado and Taos to considerable extent, an estimate for which will be found on next page.

In the valley of Taos is found at present the most valuable agricultural district in New Mexico. A population of 7,000 is engaged mainly in the cultivation of wheat and corn. Two flouring-mills are supported in the manufacture of what is considered peculiarly fine flour. Large quantities of this flour are consumed in Santa Fé, and during the year

1875, the contract for Fort Union was held by parties who filled it from this region.

The hill to the south of Red River crossing was a very bad one, but has been much improved by citizen labor, done under the direction of officers detailed by the commanding officer District of New Mexico. The grade is now good, and little is needed except widening. The next arroyo, to the south of this hill, is very steep, and although the road on the north side has been much improved by citizen labor, it is still too narrow; on the south side is a steep pull for a short distance, which should be remedied by a new location, at an estimated cost of $400. The next arroyo is descended by a siding nearly a mile long, made by much labor, and as it is very narrow, should be widened throughout, at an estimated cost of $1,000. The south side of San Cristoval Hill is bad, and should have a new location; estimate, $500. The north side of Arroyo Hondo Hill is very steep, but work here should be done by people resident in the valley. The hill of descent into the Criniguilla Arroyo is sandy and bad. It is susceptible of improvement by digging out the sand and substituting a layer of clay, which can be found in the hill. A new location would be very expensive. Estimate for this work, $700.

Incidental work along the first six miles of the new road constructed in 1874, in the cañon, requires, $300.

The embankment constructed along the lower portion of this upper cañon work needs strengthening, as it is subject to wash from high water; estimate, $1,500.

Two sharp turns in this portion are the worst places in the road, and being in the midst of lava-rock, as is the greater part of this work, the expense for correction is great; an estimate not too great is submitted, $650.

The crossing of the Embudo River, which is impassable in high water, requires a substantial pile-bridge about 500 feet long, for which an estimate is made of $2,500.

The lower cañon road, which is entirely on lava-rock, should be improved by widening the road-bed, which is very narrow here. This should be done through a distance of about three miles; estimate, $1,500.

RECAPITULATION.

First arroyo south of Red River Hill	$400
Second arroyo south of Red River Hill	1,000
San Cristoval Hill	500
Criniguilla Hill	700
Incidental work, six miles, upper cañon	300
Widening and strengthening embankment	1,500
Straightening two bad turns	650
Bridge at Embudo River	2,500
Widening road in lower cañon	1,500
Total	9,050
No allowance having been made for tools, add	350
Add 10 per cent. for contingencies	940
	10,340

In case permission can be obtained to sell the Army ration to the laborers at cost prices, fully one-third of this can be omitted, leaving, say, $6,900.

It will be recollected that when this road was opened the difficult character of the work and the limited appropriations made it necessary to attempt nothing beyond a practicable route at first, leaving its proper completion to the future.

Taos to Santa Fé.—Between Taos and Santa Fé there formerly existed a very disagreeable passage by a steep and bad road over a mountain-spur reaching from the main chain to the cañon of the Rio Grande. This spur, called the Picuris Range, could be avoided only by a long detour crossing the Rio Grande twice. Freight, except such as could be carried by burros, was almost prohibited, and the customary route for individuals going from Santa Fé to Fort Garland was via Fort Union and the Sangre de Cristo Pass in preference to attempting the more direct line.

Now, however, through the munificence of the general government, the new road constructed down the cañon of the Rio Grande, a level route, straighter than either of the old roads, can accommodate all possible travel.

The last forty miles of this route pass through a country remarkable for its barren desolation; hills of drifting sand or gravelly soil support almost nothing, and every spot capable of cultivation is occupied. Freighting by cattle-teams must always be very difficult through this region. It should be remarked, however, that the approach to Santa Fé from any direction is but a slight improvement on this picture. With the improvement in the road made between Taos and the Rio Colorado, this line would be far preferable as a stage-route from Garland to Santa Fé and the south, and, as it is, several days are saved in travel by government teams passing between the two places, and drawing their forage from the regularly-established agencies.

We have now looked at all of the existing routes to the south and southwest from the railroad termini.

Perhaps, were the freighting conditions equally as good by the west of the mountains as by the east, there would be no cause to improve upon the route last described. But we are here confronted by two rather remarkable physical features of the country, which it might be interesting and instructive to describe.

Lava-field of the Rio Grande.—In the first place, there is the lava-field of the Rio Grande. This is a tremendous exhibition of volcanic power. Commencing at the angle between the Conejos River and the Rio Grande, in Colorado, one continuous sheet covers the face of the country to the south for eighty miles unbroken, and then for fifty miles farther is now exhibited in outlying areas and detached masses, separated from the main body only by the exercise of the power of erosion through prolonged ages. One hundred and thirty miles in length, and perhaps thirty in breadth at its widest place, the area of a principality lies swallowed up forever. From craters existing, probably, in the San Antonio Mountain and the Ute Peak, and possibly in other centers, this flood poured over the land. Reaching to the east, it was checked by the mountains of the Sangre de Cristo Range; flowing to the west, the mountains and hills of the main divide and the spur now between the Chama and the Rio Grande limited its extent. To the south it was deflected westwardly by the spur of the mountains called the Picuris Range, some fifteen miles south of Taos. Protected by this spur, we find the east bank of the Rio Grande for many miles free from the flua. Confined on the west by the slopes of the Jemez Mountains, the breadth of the field is narrowed; but from the village of San Ildefonso to Peña Blanca we find the lava on both sides of the Rio Grande, spreading to the east as far as the valley of the Santa Fé Creek. Secondary centers in the Jemez Mountains possibly contributed to this extension, but the main force of the eruptions was probably felt farther to the north. However, in this vicinity the edges and extremity of the field have been

reached, and there has been so much erosion at places since its deposition that outlying masses, as in the bluffs to the west of San Felipe, alone remain. Throughout the whole region thus depicted this lava-field is the great and controlling element. The streams that have eaten their way through it with untold difficulty are found in narrow and deep cañons, having no land for cultivation. A dangerous feat for man to descend these precipices, the passage by an animal is almost impossible. The Rio Grande passes for eighty miles or more through its black abyss, with walls of seven or eight hundred feet in height, crowned with perpendicular cliffs of solid lava two and three hundred feet high. Throughout the whole region there is no agriculture. The valley of Taos is formed only by the fortunate detrition of the adjoining mountains spreading over the edges of this plain a thin soil. Outlying patches are cultivated at other points near the perimeter of the basin. Agriculture on the Rio Grande is possible only, as before alluded to, in the section that was, so to speak, in the lee of the Picuris Range, or from La Joya to San Ildefonso. The surface of the mesa itself supports a scanty grass which feeds a few wandering flocks of sheep, and the dwarf cedar proves anew its wonderful hardiness. In consequence of these features, roads across this country are almost an impossibility. From Cienigilla to the Ojos Calientes is found the only wagon-road crossing the mesa from east to west.

The fortuitous cañon of the Rio Chama furnished a route from Santa Fé to the northwest. From Peña Blanca to the west the road is possible because of the erosion of bluffs which were probably as formidable once as those of San Felipe, ten miles to the south.

The road from Fort Garland to Taos keeps to the east of the basin, touching it only at the Rio Colorado and at the Arroyo Hondo. Lieutenant Morrison's route in 1872 is unavailable because of passing over the western shore of this no longer sea of fire, where sterility and absence of water are the rule.

In the construction of the military road from Santa Fé to Taos it was necessary to follow the cañon of the Rio Grande from La Joya to Cienigilla, and the expense of the construction arose from the necessity of passing through the blocks of lava forming the *débris* at the foot of this gigantic mesa cliff.

Under these conditions the problem of passing to the west of this section becomes a strategic one of turning its flanks. The routes via the south point of the Sante Fé Range turn it to the south as well as the range itself. The proposed route will turn it by the north.

The marls of Santa Fé.—The second physical feature remains to be described. Underlying this gigantic field of lava, probably throughout its whole extent, certainly in its southern portion, there exists a series of immense beds of marls, sands, and clays, and imperfect sand and limestones. Of many hundreds of feet in thickness, the coarse character of the sand and the immense quantities of gravel show that they are formed by the very rapid erosion of a lofty mountain-range. From this cause the formation of a finely comminuted soil has been impossible. Barrenness and desolation are the results, and the country to the south of the Picuris Range and Santa Fé and its vicinity suffers accordingly.

The foot-hills of the mountains and the valley of the Rio Grande are alike sandy and sterile. Narrow strips of ground are irrigated in the immediate vicinity of the streams, but away from these feebly-green spots aridity and bleakness extend. There is no grass except during the few weeks succeeding an unusually protracted rainy season. Cattle learn

to eat anything that is green, and the sight of the goat eating the thorny stems of the tall cactus is no more striking to the stranger than to see the gaunt ox feeding on the running pine and the dwarf cedar. Sheep and cattle are driven from this region to the "Conejos Country," full sixty miles, to pasture and to winter. The valley of the Chama is similar in its character, being formed by the excavation of the same beds of marl, and the Rio Grande below the junction of this stream never loses its predominant characteristic of sand. These marls extend to Santa Fé and farther south. The Santa Fé Creek irrigates a small portion of tillable land some six miles or more in length in the immediate vicinity of Santa Fé. Besides this and a starving hamlet at Galisteo no sign of civilization breaks the desert solitude of sand and gravel that stretches southwardly down this elevated plateau, save the isolated ranches near the rare springs of water, such useful oases in the passage of this divide. The civil division of the country of Santa Fé very nearly covers this barren area from the Rio Pojoaque to Galisteo. In this country, with a population, by the last census, of 9,699, there is reported as the total area of improved land 10,925 acres only, with a total annual value of farm-products of $99,410, or about $9 per acre. This in a country where corn is cheap at 2 cents per pound. The production of wheat was given at 6,314 bushels and corn 20,262 bushels. Beyond necessary working-cattle and horses no stock except sheep are kept in this region; 630 having been reported as the total of "other cattle," held in the country. To avoid the lava-field in going to the west by the south from Fort Garland we necessarily encounter at least sixty-seven miles of this desert.

It might not be an impertinent digression at this point to answer the question why was Santa Fé established in the face of these disadvantages? Its lovely climate, protected as it is from the north by its near mountains, and elevated at 6,840 feet into an atmosphere charming in its freedom from moisture and balmy in its mildness, may perhaps have had its influence. An abundance of excellent water is found at a short depth by digging wells at almost any point of the locality and fresh and sweet; it alone in those regions is reason sufficient for settlements. The immediate vicinity probably supplied its earlier inhabitants with sufficient food for their limited numbers. By reason, then, of these two formidable features it has not been advisable heretofore to use the route thus described in passing from Colorado to Western New Mexico. As shown, however, progress in railroads has made this route a desirable one to Southern New Mexico in case it shall be improved, as indicated before, between Taos and Fort Garland.

It is now necessary to describe the lines of reconnaissance and survey examined in search of a new route, and to give a general view of the country through which they pass.

DESCRIPTION OF NEW ROUTES SURVEYED.

Lieutenant Morrison's route in 1872.—In 1872 Lieutenant Morrison made a reconnaissance by the west side of the Rio Grande. Crossing the river at Meyer's Ferry, he went down the lava-field near its western edge to Ojo Caliente; thence by a long curve to the west and north he crossed the Chama some fifty-three miles from Ojo Caliente; from this point down the course of the Puerco to the road from Peña Blanca to Wingate, and with it to that place. Unfortunately his report was not as full as it might have been, and I shall endeavor to supplement it from other sources.

It is an interesting historical fact that during the suppression of

the Indian insurrection in New Mexico by the Spaniards in 1690–'93, an expedition to conquer the Pueblos of the Taos Valley having been longer in its undertaking than presupposed. found itself blocked up on its return to Santa Fé by snow in the Picuris Range. Fearing to attempt the passage under the circumstances, the plan was adopted of going north into the Utah country, now Colorado, crossing the river above the cañon of the river Grande, probably in the vicinity of the Rio Costilla, and then returning to the south. The line of march on the west side of the river was the same as that followed by Lieutenant Morrison, and the lapse of one hundred and eighty years has found us in nearly as intimate a knowledge of this country as the Spaniards had then.

Conejos to the Chama.—The lava country, of course, through its whole extent, furnishes hard roads, level in stretches, and very rough from detached fragments, which have an almost perfect hardness, weathering very slowly and never crushing into macadam. The cañons of the water-courses on this route and the edges of the field are descended by very rough and very bad roads, incapable of permanent improvement, and not even easy to be bettered.

The longest distance without water is twenty-five and one-half miles, being that from leaving the Conejos and its tributaries to some water-holes on the lava-field. The last stretch of seventeen and one-half miles into Ojo Caliente is without water, and as the road has left the lava, the sand of the marl formation thus discovered makes the traction difficult.

Rolling country and steep hills between Ojos Calientes and the crossing of the Chama, in addition to the undesirableness of the preceding section, do not tend to reconcile one to the long detour thus made between the Conejos and Upper Chama in order to avoid the mountains of the direct line. In this section Lieutenant Morrison examined three routes, and of these recommended one which would necessitate some work before it could be used by wagons. The others have objections to their use in being longer and in other features of a physical character.

Were the curve of the more level route located through a prosperous region, or were the roads smooth and quickly traveled, with good grass and abundant water at reasonable distances, it might not be considered worth while to attempt to shorten the line by passing over a chain of mountains. But when the mountain-route has its usual advantage of water at all points and good grass, and its grades are fairly reasonable, the question of cost of construction may well be considered. And when in addition to this the saving in distance, as in this case, amounts to fifty-five miles, the economy of a judicious investment is well-nigh manifest.

The Jemez Mountains.—The mass of the Jemez and Gallinas Mountains necessarily deflected Lieutenant Morrison's line, and the northwestern point of this obstruction was the objective from Fort Garland selected by me in the line surveyed. The mountains form a bold and imposing feature in the landscape. Rising in swelling masses and terraces, they are always grand in effect and graceful in outline. Culminating in one high summit, every defense of bastion and outlying rampart seemed combined for its protection, alike from the attack of man or the fiery onslaught of natives. Though lofty enough to be surrounded by the summer-clouds and darkened by the summer-storms, these mountains are not of sufficient area to form and protect mountain-streams, as does the Sangre de Cristo range. Agriculture, therefore, is represented only by the scanty fields of the Jemez River or the with-

ered banks of the Puerco. No communication exists through its forbidding cañons, nor indeed does the prospect even invite a search.

Rio Chama to Wingate.—To the westward still we find the great Atlantic and Pacific divide, with a general direction of south-southwest. Having turned the Gallinas Mountains, our crossing of the Rio Chama is found to be probably not more than fifteen or twenty miles to the east of the crest of the divide. From this point to Blue Water station, a distance of one hundred and forty-seven miles, the road is sensibly parallel to the line of the crest. Bacon Spring is found on the west, and is the first water encountered on the Pacific slope.

The general character of the country, from the line of the road to the north and west, is very much the same everywhere. Recent sedimentary rocks, and soil from their detrition, are the geological features. The altitude of the divide is not great, rarely over 7,000 feet, and the rain-fall is very slight. But the soft soil washes very easily and the water-courses to the west become cañons at short distances from the sources. Two of these cañons have been carefully examined and described.

The Cañon del Chaco was reported by Lieutenant Simpson, in 1849, to contain remains of a former population of considerable size. Its rocky walls now look down only on a dry bed and dusty ruins. Pueblo succeeding pueblo formerly lined the banks of what must have been a fertile river-valley. To-day not even is it safe for the passing train to depend upon finding sufficient water there except during the rainy season.

Capt. J. H. Macomb passed through the Cañon Largo in 1859, finding it still more desolate than the Cañon Chaco, although exhibiting ruins indicating former habitation. The great divide itself is not a precipitous chain of mountains, but rather a rounded plain, and the whole country is made up of approximately plain surfaces, now cut up into gigantic sandstone mesas, crumbling, dry, and barren. The only routes that can be followed are by the gorges between. It is impossible to cross the system, save with much work and many detours. The topography of this feature is well illustrated by the detail sheets of the accompanying atlas and also by the general map.

However desirable it might be to rectify the line of the route between Chama and Fort Wingate, it would be difficult, if not impossible, to do so with a wagon-road. If we pass to the west, we shall find ourselves on the dry crest of the divide; if still farther to the west, we are in a dearth of water, and a difficult line to travel for all possible reasons.

Lieut. G. S. Anderson, Sixth Cavalry, surveyed in 1874, under my directions, two routes over the Chama spur of the main range. These two routes led from the settlements on the Conejos to the Wingate or lower crossing of the Chama. My former report contains minute details of these lines, both in respect of natural obstacles and proposed means of correction. Since that time chartered toll-roads have been commenced over both of these lines, and this whole subject will be reviewed further on.

Lieut. C. A. H. McCauley, Third Artillery, on duty in this office, was detailed in the spring under the specific instructions of the department commander to examine and report upon all existing or needed roads in Southwestern Colorado and Northwestern New Mexico. An immense amount of information on this subject has beem obtained, and is now being digested. At present Lieutenant McCauley submits a report upon those lines leading to the southwest from Fort Garland across the Chama spur and thence to the lower New Mexico country, the Fort Wingate region or the southwest, and the San Juan country or the west. All

of these routes are of great importance in a military point of view, and Lieutenant McCauley's descriptions and summary are of value, and his conclusions as hereinafter given are approved by me and incorporated in my own general summary formed later.

At the close of Lieutenant Mc Cauley's portion of this report the remainings portions of the routes in question will be described and the general recommendations made.

THE SAN JUAN COUNTRY.

This noted region, bidding fair to become in time one of the richest silver-producing sections in the world, is that portion of Colorado lying in the southwestern part of the State, to which of late emigration has rapidly increased, and the attention of capital been attracted by its fine agricultural valleys and the great mineral wealth of its mountains, so that several towns and numerous settlements have sprung into existence in remote localities, while much of the country has been occupied with a view to farming and pastoral pursuits.

The appellation of "San Juan" is derived from the river of the same name, into which pour all the streams and waters of the lower country. Long before the advent of the white man upon the continent its banks teemed with an unknown population of whose habits and mode of life history speaks not and tradition is silent, with naught to aid the intelligent investigator save fragmentary pottery and the ruins of their dwellings. After long lapses of time, their former lands are being occupied by the progressive Anglo-Saxon in his inexorable movement westward.

Within the last quarter of a century, the country had been penetrated in part by explorers, and reports of the wonderful wealth in its mountains had attracted thither, at the risk of death from hostile red-men, numbers of prospectors. A tide of immigration set in, and nearly two decades have passed since the same kind of adventurous spirits as at present may be found there were flocking to the country. Disappointments, continual attacks of hostile Indians, and other causes combined to stay the tide, and with its reflux the lands were left to the tribes that possessed them by virtue of original habitation.

A comparative wilderness, unoccupied by whites, the country remained unnoticed or forgotten until 1870, when it was again penetrated by a small party of prospectors with the resulting discovery near the present town of Silvertown of the "Little Giant," a gold lode famous for the value of its ore and notorious in subsequent litigation. Their wonderful discovery, bruited abroad, was the cause of another influx, solely of hardy prospectors, resulting in the establishment of a permanent population.

In the treaty of March 2, 1868, setting aside for the Utes all, save a fragment, of Colorado west of the one hundred and seventh meridian, the San Juan land became a definite portion of the Indian reserve. Their numbers and hostility were too powerful to be overcome by the settlers within their country; the white man demanded the valuable territory of the weaker one, and force compelled him to yield. What is generally known as the Brunot convention, from the name of the United States commissioner, ensued. Articles of agreement for the cession of the San Juan were entered into September 13, 1873, by the confederated Utes, and the necessary satisfaction made by Congress April 29, 1874. The portion ceded by the Brunot convention contains about 6,000 square miles, and includes all of the rich mineral sections save the Summit District, a gold region; that part of the State generally known as the

San Juan country, comprising, however, in addition to the above contiguous territory aggregating over 13,000 square miles, one-eighth of the entire State, and an area equal to that of Massachusetts, Rhode Island, and Connecticut combined.

In the lower portion of the great Continental Divide, in a general direction of northwest and southwest, is for 125 miles or more known as the San Juan Mountains, including many lofty peaks and spurs.

For convenience of treatment, the main agricultural region, watered by streams and rivers springing from the summits and flowing down on the southern and western trend of the range all on the Pacific watershed, may be distinguished as the lower country; the rest the upper.

LINES OF COMMUNICATION.

Roads are the highways of civilization. Their construction is the first and essential stage in the gradual development of any section. Without an easy outlet for its resources, no country, however productive, can acquire that wealth and prosperity which free and easy communication alone can furnish. This is particularly so in an inland section and a mountainous region. The discovery of the precious metal is almost invariably made by one or more adventurous prospectors, whose outfit, of the most modest nature, is generally borne upon "burros," or jackasses, capable of climbing over difficult mountainous country. With the discovery of a fine mineral deposit, their log cabin is established, becoming the nucleus of a mining-camp. The outlet and inlet by a trail permitting pack-trains only with the advent of new-comers, an embryo town appears, and well-watered lands *en route* are taken up for grazing and farming purposes.

With increasing signs of permanency and material wealth, the necessities for a wagon-road become daily more evident, until it is finally furnished by some enterprising capitalist, or a stock company, and the settlement is opened to the basis of supply.

From this dates permanent prosperity. Slow-moving pack-animals are succeeded by more rapid freight-trains, with greater carrying facilities, high prices for commodities of life and business are diminished, and the stage-coach appears upon the scene. Easy access, well-rewarded labor, and profitable investments invite the laborer and immigrant, as well as the speculator. The country increases in agricultural and mining industry until, with the lapse of time, the railroad approaches and the frontier settlement assumes a metropolitan air; and on the march of civilization continues.

The roads of the San Juan are, therefore, of prime importance, and whatever can be done to shorten the lines of communication and open as yet undeveloped sections will be of the first and most material value.

The recent advance of the Denver and Rio Grande (a narrow-gauge railroad) over the Sangre de Cristo Range has enabled it to control all the freight and passenger traffic destined for the San Juan, as well as all of New Mexico, save the northeastern part. Its present terminus is Garland City, 6½ miles from Fort Garland, situated in the eastern part of San Luis Valley, at the foot of the western slope of the mountain, whence travel for the upper country passes northwest to Del Norte and via the toll-road up the cañon of the Rio Grande to the settlements beyond, while that for the lower takes its course due southwest, passing Conejos, a Mexican plaza, known also as Guadalupe.

Of the lower country the seat of the largest population is that part of the valley of the Animas known as the Animas Park, lying in a gen-

eral direction north and south, and containing over 10,000 acres of tillable land, susceptible of easy irrigation, above which, and beyond the grand cañon of the river, lies the largest populated region and the seat of the greatest mineral wealth.

Silverton, upon the Animas, and other towns and contiguous mining camps, may be reached from the railroad and Del Norte directly by following up the valley of the Rio Grande and crossing the mountain-range that forms the divide between the waters of that and the Animas; more indirectly, by reaching the lower country and the Animas, and thence passing up the cañon of the river.

As the lower country is the least favored with respect to outer communication, it may be well to first consider it. Hemmed in upon the north and east, which, with outlying spurs that contain many peaks of great altitude and few practicable or natural passes, the summits of the mountain-chain lie approximately in the arc of a circle with Pagosa Springs nearly at the center. It is, moreover, south of the position of Garland City but 11 miles, being about 100 miles west thereof. From the railroad terminus all roads to the lower country at present have a common point, viz, the crossing of the Chama at the plaza of Los Ojos, one of the villages of the Tierra Amarilla section, whence the main-traveled line, known as the "Upper road," passes to the Animas, via Pagosa Springs, while the distance to the Animas is greater by this than by the route called the "Middle road," which, passing by the Laguna de los Caballas, Piedras de Legunados, and the Cañon Curaçon, to the San Juan below the mouth of the Navajo, and crossing the Rio Piedra and Rio de los Pinos, unites with the upper road on the Rio Florida; it is preferable to the latter, on account of more frequent water and the fine grazing along the route, timber being everywhere abundant. Hence, from its natural position and the relative points of supply, Pagosa becomes a strategic point, and the line which will easiest and quickest enable travel to reach it will, and in fact must, become the popular and frequented route.

The Rio Grande River, which emerges from the mountains at Del Norte, taking a southeasterly course through the San Luis Valley, is, during most of the year, easily passed, being fordable with but little difficulty at a number of points from Del Norte south. Like all streams, however, that spring from lofty summits in the main range and are fed by banks of eternal snow, it is subject to great increase in its waters during the spring months of the year. The small brooks become waving rivers, and with difficulty are crossed, where earlier and later the passage may be a matter of no difficulty. At such times the Rio Grande is a formidable barrier, and can be crossed only by bridge or ferry. A few miles below Del Norte a bridge over the river secures travel of all kinds from any interruption at all seasons, while that below, bound southwest, finds passage during high stages of water in one or two ferries that are located on the lines of travel.

THE LOWER COUNTRY—GARLAND TO CONEJOS.

From Garland City to Conejos and the southwest two routes are optional. The first, in a general southwesterly course north and not far from the Rio Trinchera, crosses the Rio Grande just above its mouth, at a distance of 19½ miles from Fort Garland and 26 miles from Garland City. Thence it continues some 26½ miles due southwesterly along the north bank of the Rio Conejos, a tributary of the Rio Grande, with its mouth a mile below the Trinchera, reaching the plaza of Conejos at a distance from the railroad of 52½ miles.

Part of the way on this route another road may be taken by crossing the Trinchera a few miles below Fort Garland and continuing south of, and near it, about as far distant as the former above. It reaches the Rio Grande at the mouth of the Conejos, whence, passing due west, it comes into the other road at a distance of 4 miles. While no appreciable distance is saved by this route, its only advantage ordinarily being, perhaps, a preferable ford to the one at Stewart's, it, like other points, presents no crossing-place over the Rio Grande during high-water seasons and hence will not be considered.

The second route from Garland City passes a little west of south to the Rio Culebra, crossing it at Mexican plaza of Lower Culebra, thence southwest to the Rio Grande, where is the ferry formerly kept by Mr. Fred. Meyer, now in the hands of Señor Valdez, 39½ miles from Garland City, 33 from the fort; thence the road passes due west to Conejos, 18 miles distant, and 57½ from the railroad. Both roads lie wholly in San Luis Valley and are natural ones, as easy in traveling and as hard as the ordinary prairie, save in a few places where they are heavy from shifting sands, a belt of which extends over the valley.

In June, while in that section, a whirlwind would here or there keep in sight almost constantly a cloud of sand, and as they occasionally passed, they shut out completely earth and sky, filling eyes and ears, taking along hats and other movables if possible—happily a brief visitor, leaving as a souvenir a fine stratum of sand. The height to which these moving, flying pillars rose, seemingly gathering strength as they whirled along, was very great. The approach to the Rio Grande on the upper or Trinchera road is over low ground. During the high-water season the river reaches back for some distance upon either side, and with its diurnal fall and rise the ground, at other seasons hard and dry, is changed to a marsh, and easy access to and from the river-ferry is for heavy teams often quite problematical.

In our crossing the ferry in June last, one of the wagons of the train, in the detour which is selected as the best approach upon the eastern bank, mired twice in the boggy-ground, and caused a delay of two hours; upon the opposite shore another long and tedious delay resulted, the road being two feet under water, necessitating unloading by hand in water above the knees. There is a bend in the course of the river just above the ferry, and as the ground here rises but slowly from the stream outward, it is at the best a faulty location for such a purpose.

The river was then about 150 feet in width, with a very rapid current. The ferry-boat, rather a small affair, about 20 feet in length, barely held an army-wagon and the wheel span of the team; a flimsy rail was along each side, protection chiefly in appearance, each mule requiring holding during the passage. In taking over the cavalry escort, the horses were led on the boat, heads alternating up and down stream, to equalize the load, which was limited to eight. A crossing with horses only was made in eight minutes, and four six-mule wagons, including the teams, were ferried over safely in one and a quarter hours. A small pier or planking of some kind was lacking, nothing of service in the nature of gangway being provided. The rates charged were, for single horsemen, 50 cents; light wagons, $1.25; two-horse wagons; $1.50, and four-horse wagons, $1.75. The ferriage was, however, reduced in consequence of the size of the party to 25 cents per animal, riding and team, with no charge for wagons. The more direct and better road, as before stated, is up the course of the Conejos river, above and skirting the edge of the plain, always high and dry; it is, however, nearly barren of grazing, in need of which the command took a left-hand road at a distance

of about 12 miles from the ferry; this passes over what is known as the Island, a long point of land included between the San Antonio and Conejos Rivers, across which, during high water, flows a net-work of small streams, rendering it the best watered and most fertile land in this section; it is, without doubt, the garden-spot of the entire valleys of the two rivers, and would be literally "flowing with milk and honey," were it in the hands of eastern farmers instead of those of Mexican descent, whose ambition is generally satisfied with cigarettes and a "baile."

The Conejos was crossed at the plaza of Los Cerritos (more properly called Las Sierritas, the "Little mountain," taking the name from some high hills that are grouped near by), whence the road soon passed into that from Chavez ferry to Conejos.

The passage of the Conejos was made without loss, though not without difficulty, the stream high and rapid, with about a six mile current, was in the beds of the rivers, and one of the team-mules falling in the river and becoming entangled in the harness, was with difficulty saved from drowning. From the appearance of the banks at 1 o'clock p. m., it was evident that the water had very lately fallen fully a foot.

Chavez ferry.—The ferry on the lower road differs in location, &c., materially from that above. It is in a direct line 18 miles south of it, by the windings of the river about twice as much; a trail leading down from the upper ferry, which is called by the Mexicans but 12 miles. This ferry, formerly known as Myer's Ferry, and described in 1874 as a "dilapidated affair," was purchased from Mr. Myer in the spring of 1875 by Señor Caledrina Valdez, the present owner, for $450. The boat sunk in the following fall, and last spring it was replaced by the present one, very serviceable and greatly superior to Stewart's. It is about 45 feet long and 12 in width and strongly constructed of stout timbers. A strong side railing is provided, and a small row-boat is in tow, for a possible necessity, certainly a nice precaution; for the river in June was here 10 feet in depth and about 250 feet in width. The cable is firmly held upon strong piles about a foot in diameter, with heavy triangular braces, thence passing over a windlass to the rear. The crossing with a load was made in four minutes. The charges are about the same as at Stewart's; its capacity greater. The owner reported that at a single crossing they had carried 400 sheep, the charge for the trip being $5. In its location this ferry has, furthermore, an advantage over its rival. The river is here about 25 feet below the general surface of the plain, and as the road descends gradually and easily, no possible miring of teams can occur. A short distance below this point the Rio Grande enters its long cañon, which increases in depth southward, the lava sides vertical or piled with sharp-edged rock, perfectly impassable, and a veritable scene of desolation in nature.

To the San Antonio River, *en route* to Conejos from the ferry, the road s a magnificent natural one, fine, hard, and level; on the way, upon either side, some two or three miles off, rise rounded hills with sand-stone strata, on which lay the cold, volcanic rocks, blessed with but little timber, and that but a poor piñon, with an occasional cedar, the only kind that will befriend so dismal, inhospitable a surface. Lava rock lie strewn along the bases of the hills and out over the plain everywhere; its hot and parched surface relieved only by an occasional breeze from the mountains to the west. Its vegetation is exceedingly sparse, almost nothing save sage-brush and a few cacti breaking the monotony. No grazing can be found at or near the ferry, nor on the lower road to any extent beyond the crossing of the Trinchera, until the San Antonio is

reached. The latter was found very high and the ordinary ford impracticable, necessitating our crossing a mile lower down.

Of the two routes from Garland to Conejos, the upper or Trinchera is preferable. Its chief disadvantage is the inferior condition, in addition to low approaches of Stewart's ferry as compared with that of Chavez, the latter as a crossing being greatly preferable. The upper route has, however, several advantages over the lower not to be lost sight of, which are mainly—

1st. It is considerably shorter.

2d. Its hard surface or natural road, save a small sandy portion, less than half of that on the other.

3d. Wood, water, and sufficient grazing for convenient camping places at no long intervals, the Conejos being timbered with cottonwood.

4th. Except the Rio Grande, but a single stream of any importance to be crossed, the Rio Conejos at the plaza of Conejos (or Guadalupe), while on the lower road are the Trinchera and Culebra east of the Rio Grande, and the San Antonio on the west. By one route a bridge is essential for the Conejos, by the other for the passage of the San Antonio. At the plaza of Conejos the river was formerly passed by a bridge which was, they there informed me, washed away in 1874. After numerous resolutions to replace it, the citizens have let the matter drop, and teams now find their way over as best they may. At the town, fortunately, there is a spot where the river broadens to over three times its usual width, so that generally a passage may be found. The river here is about 200 yards and the approaches low, so that a slight rise in the water materially increases the difficulties of passage. A superior location may be found not far distant and the river bridged at a cost not exceeding $1,300.

CONEJOS TO PAGOSA.

Communication between the above may be considered under the following heads:

1st. Old line via Tierra Amarilla section.

2d. New line via Tierra Amarilla section.

3d. *Proposed* lines.

1st. *The old lines.*—Up to the present summer the only mode of access from the railroad to the Lower San Juan was from Conejos southward to Ojo Caliente and northwest to Tierra Amarilla, a distance of 150 miles. A cut-off above Ojo Caliente via Cueva, shortening this distance to 120 miles, has diverted travel in its favor. It is in general a good and easy road, being largely over country with a hard and level surface, having been the scene of some volcanic eruption; some mesas passed over present difficult points, the chief objections, however, being the absence of grazing and the long distance between water making it an exceedingly hot summer route.

Crossing the Chama at Los Ojos, where it was about 75 feet wide, 2½ feet deep, the "upper" route is over a natural road, through low valleys or over gently undulating hills, covered with fine grass wherever sheepherds may not have tarried. The Continental Divide is here a line of sharp mesas of the steepest kind, 400 to 600 feet in height, with sandstone outcroppings and sides timbered with scrubby piñon. The road winds so gently through an easy pass between, that one can scarcely realize the passage from the Atlantic to the Pacific watershed. A dearth of water existed in July last between the Chama and Navajo, and for 33 miles no running water was found, although many dry beds of streams were met with, which heavy rain-storms of the previous day

and night had failed to fill. The soil is to some extent alkaline, and upon pools of rain-water our camp depended. From the Navajo to Pagosa, 23 miles, water is abundant, the Blanco and tributaries being rossed *en route*. Pagosa being 56 miles from the Chama at Los Ojos, necessitated a journey of 206 miles to reach it from Conejos—reduced tq but 176 via Cueva—a long and tedious trip.

2d. *New lines via the Tierra Amarilla section.*—From Conejos two roads are now constructing, both following the general lines of survey examined by Lieutenant Anderson, Sixth Cavalry, in 1874, in obedience to instructions from the chief engineer of the department.

The first, which may be known as the

CHAMA ROUTE,

ascends the Conejos for 11 miles in a fertile and cultivated valley over a natural road-bed. Its direction is a little south of west, and its grade during this distance only about 39 feet per mile, or less than 9 inches rise per 100 linear feet, practically a level. From this point it passes nearly westwardly for 20 miles, in which it reaches the Los Pinos Creek, above the deep and impassable cañon of the central part of the stream, along which it follows for about 3 miles, thence ascending the low divide that separates the watershed of the Conejos and its tributaries from that of the Chama and its branches, it passes to the slopes of the latter streams, with its highest point not over 9,800 feet. In this section the average grade is about 75 feet per mile, or a rise of 1⅓ feet in 100 linearly.

As the summit of the divide is approached, a number of low hills of gentle slopes are passed, along whose sides easy grades, at no point exceeding a 3 to 4 foot rise per hundred linearly, are readily obtainable, so that at no point is there anything so difficult to overcome as to need special mention. Leaving its westerly course, the road passes southwest for 13 miles, following first a tributary and then the Chama itself, and in a southerly direction by the banks of the river, some 16½ miles, to Tierra Amarilla, as the main plaza, Los Nutritas (2 miles beyond Los Ojos), is generally called, a total length of 60.69 miles, as measured last July. The entire route is well supplied with grazing, timber, and water; springs and nutritious grasses being particularly abundant in the most elevated regions. Via this line, the distance of Pagosa from Conejos is reduced to 114.7 miles.

In the spring of 1876, a settlement called Park View was located 2 miles above Los Ojos, in the valley of the Chama, by a Chicago and Santa Fé company. Circulars with information of an enticing character to promote immigration were circulated. The town was passed on the 9th of July last, in a lovely valley with about 8 acres, not exceeding 10 at most, under cultivation; eight cabins of the settlers being scattered about in the fine forest adjoining. The charter for the road from Canejos to Los Ojos was taken out with the view of making it a feeder to the colony, diverting trade of the vicinity from Los Nutritas, its present center.

To have reduced so materially the long detour by Ojos Caliente or Cueva was a desideratum; and to avoid this, travel at once started over the Chama line by Park View, it being announced last spring by those in charge of its construction that it was passable. The apparent object was accomplished, that of getting teams over a part of the road which nature had prepared, when, part way in, rather than return, the freighters

would work along to enable their teams to get through; for in no sense of the term was there a way ground in existence over most of the route.

Having been personally and authoritatively assured in June that no difficulty whatever would be experienced in getting through a wagon-train, as much machinery had already been transported over it, we started from Conejos July 4, reaching Tierra Amarilla on the afternoon of the 9th. Over the central part of the route, three entire days were taken up in going 19¼ miles. This distance was over side slopes, summits of hills, and some arroyas; the train being gotten over safely, however, by changing the front wheels of each wagon to the up-hill side, the rear ones being on the lower one, holding up the wagons with ropes, using large logs as pulleys and picket lines in ascending arroyas, and resorting to similar expedients.

While the general route is one perfectly adapted to the end in view, the location was found very faulty, the road passing over tops of little hills and abruptly down the ends, instead of seeking a uniform and easy grade along the sides. I have been since informed by the officers of the road company that it is now everywhere in complete order—new locations having been made in the faulty localities. Lieutenant Gibbon traveled over this road in September, reaching Tierra Amarilla from Fort Garland in four days. His report contains no remarks on this part of the road, except that 12 miles remained uncompleted.

The second and rival route, which may be known as the

SAN ANTONIO,

in contradistinction to the former, approaches nearer a direct line. Ascending the valley of the Conejos, to include the plaza of San Raphael, it passes south across the plain to the plaza of San Antonio and contiguous towns in the fertile valley of that river, near which it is crossed. Thence it passes almost due south, near the right or east bank of the river, and between it and San Antonio Peak, following what was an old Indian trail southwest over the divide. Thus far the construction will be inexpensive, as there is at present a hay-road used by the Mexican teams up to this point—the chief items of cost being slopes of volcanic mesas that are met with, and the bridge over the river. When once put in traveling order, this part will but rarely need repair.

From the time of departure from the San Antonio, west of the Peak, until the volcanic field intervening to the mountains has been passed, occurs an interval, much less than a day's drive, however, between water, after which it is found at short intervals. The route over the range is similar to that of the Chama line, over an easy pass and through low valleys or depressions between the elevated ridges.

Several small streams, tributary to the Servilleta, a creek flowing southeast into the Rio Grande, are crossed near their heads, together with one on the Chama or Brazos watershed. Thence it passes to Las Nutritas, not far from its head and some eight miles distant from the plaza of the same name (Tierra Amarilla), to which it proceeds along the bank of the stream in a westerly direction, the total length of the line from Conejos being 55 miles. Over this latter part is already a road used by hay-wagons, and along the trail followed in general by the route Mexican shepherds have for years driven to and fro their numerous flocks—a favorite range, on account of the fine grazing and water in the mountain parks and valleys.

Timber being abundant in the elevated regions, there will be little expense, save where it may be needed for small bridges or corduroy.

The route being much of the way parallel to the line of drainage, there will be obviated what are always two items of considerable expense in such localities—cutting on side slopes for embankment, and side ditching above the road for drainage. The melting of snows on the mountain slopes, and the thawing of frozen surfaces in the spring, keep such a surface constantly moist, and a road inclined to the flow of water boggy and miry to a great extent, on being traveled.

Save the short section of 8 miles from Nutritas Creek to the plaza of that name, the entire road will be a portion of the shortest line *en route* from the railroad to Fort Wingate and the Arizona posts. From the Nutritas, the latter passes southwest to the Rio Nutria and the Chama, reaching the latter at the mouth of the former, where it is intended to bridge the river.

To consider briefly this in relation to the route to Fort Wingate, the distance, as surveyed by Lieutenant Anderson in 1874, is from the point of departure from the road to Tierra Amarilla (which place is 8 miles distant; Conejos being 47), down to the crossing of the Rio Chama, near the mouth of the Rio Nutria, 18.2 miles, making the Chama crossing distant from Conejos, by this, the San Antonio line, 65.2 miles.

Via the Chama road, as above stated, the distance from Conejos to Tierra Amarilla is 60.7 miles. The crossing of the Chama River by the Wingate road, having been found to be 14.5 miles distant from Tierra Amarilla, in an examination made during September last, by Lieut. D. J. Gibbon, Ninth Cavalry, we have the following summary to the Fort Wingate route:

Wingate crossing of the Chama River—	From Canejos.	From Fort Garland.	From Garland City.
	Miles.	*Miles.*	*Miles.*
Via Chama route and Tierra Amarilla	75.2	121.2	127.7
San Antonio route	65.2	111.2	117.7
Distance saved by San Antonio	10	10	10

A charter for the construction of the San Antonio road, under the name of the "Tierra Amarilla and Narrow Gauge Wagon Road," was taken out March 5, 1877, and filed on the 29th of the same, the incorporators being five men of means, any one of them being alone able to construct the entire line. The capital stock is $15,000, over half of which, I have been informed, has been paid in to the treasurer. The necessary tools were purchased last summer, and it was intended to have the road completed and open this winter, but the small-pox epidemic, advancing up the Rio Grande, reached that section and proved a terrible scourge. Most of the able-bodied men of the country suffered from the disease, and at Tierra Amarilla, during the summer and fall, there were over 200 deaths. I have been informed by one of the officers of the company that work thereon will be commenced at both ends of the line as early as practicable in the spring, opening it for summer travel. The directors being men of capital and controlling all the trade and produce for miles about Tierra Amarilla, the statement may be relied on, inasmuch as its construction will be a good speculation, increase the business of the vicinity and probably not entail the expenditure of half,

perhaps not over a third, of the capital in opening the road to passengers and freight.

The advantages of the San Antonio over the Chama route are as follows:

1st. To Tierra Amarilla from Conejos several miles shorter; to the Chama crossing, *en route* to Pagosa, about the same, nothing more, certainly, with equally fine advantages in the natural supplies of wood, water, and grass.

2d. With no portion of the route in a region more elevated, it lies farther south, and the general lines of drainage being from the summit of the range to the east and west, it will be exposed to winds and storms from such directions only, and sheltered on the north, leaving travel less liable to interruption.

3d. It is a portion of the shortest and most practicable line between the railroad and points in the Southwest, or Fort Wingate and other Arizona posts, and should on that account have been built by the government. The amount of freight in the shape of Army and Indian supplies shipped to that point is very large. The charge of the toll-road company, judging from the usual prices on the mountain-roads of Colorado and New Mexico, will be $2.50 per freight-team of six mules.

No greater economic appropriation could have been made on the part of the government than the amount for the construction of this line asked for in 1876.

Turning to the San Antonio line, it will be seen to be but a portion of a mountain route through and along western slopes of the ranges, which are all a continuation of the San Juan Mountains and part and parcel of the Rocky Mountain system, and as a mountain-line it is preferable to a highway on the plain, with its natural supplies of wood, water, and grass.

At this point it seems just that the conclusions drawn and recommendations made in the prior report on lines of communication between Southern Colorado and Northern New Mexico be referred to again. In that report the predictions made concerning railroad extension and its probable influence on this subject were carefully stated, and those predictions have been literally fulfilled. In that report two lines were described as having been surveyed for improved roads; over both of these lines charters for toll-roads have been obtained, and the road over one line is in use. The recommendations made from this office, if followed out, would have resulted in economy to the government and the roads would have been better made and sooner than now reported.

3d. Proposed lines.—1st. By both the Chama and San Antonio routes, there is required a long and unnecessary detour to Pagosa. Add to this a long march without water, or dependence upon capricious rain-storms, and pools muddied oftentimes by sheep-herds, between the Chama and the Navajo, and we find an imperative need of a shorter, more direct route, well supplied with water, wood, and grass.

The location I found preferable for so desirable a line, a cut-off on the Chama, may, from its situation, be known as the

CHAMA NAVAJO.

The great continental backbone, hemming in upon the north and east the lower San Juan region, abruptly changes at about latitude 37°, the dividing line of Colorado and New Mexico, from a chain of lofty peaks with high connecting mountains to a series of lower ridges with high elevations detached and at greater intervals. Immediately to its south,

and at the very base of the Chama Peak, whose elevation is 12,200 feet, occurs an exceptionally fine pass fully 3,500 feet below, watered by the west fork of the Upper Chama, completely protected on the north and east by the mountains and out lying slopes, with the summit of the divide to the northwest. This mountain-valley lies sheltered and warm, exposed chiefly to winds from the south only. Possessing the requisite elevation to impart to its grasses the peculiar flavor of a mountain growth, it is perfectly adapted to heavy traffic, for which subsistence for animals should be found in abundance, and is in every respect preferable to any already described, as a short line to the west.

Leaving the Chama route, on the upper part of that river, near the mouth of the main tributary that comes from the east, crossing the main stream and sweeping in a curve to the south and west to avoid high basaltic mesas and vertical walls of rock that shut out the river from passage and approach as securely in some places as a box-cañon, we reach the valley of the West Fork. On easy grádes it can be ascended to the divide, which is lower than the one on the Chama line; this passed, brings us to the Navajo, down which it follows for about 5 miles in a westerly direction.

This section is an especially fine grazing region, and abundantly supplied with timber. Herds of Mexican sheep are driven into the valley of the West Fork, and the Ute Indians, for fully two months last summer, had established their camp upon the Navajo in this vicinity. This river is their preference of all the eastern streams in the lower country, and its valley will make an excellent farming or cattle region. Leaving the Navajo, at a few miles distance northwestwardly, tributaries of the river are crossed, whence, after the passage of the main divide between the water-sheds of that and the Blanco, we reach at a short distance the present "upper road" to Pagosa.

The distances on the Chama Navajo are as follows:

	Miles.
From Conejos to point of departure from the Chama road	33
Thence to Rio Navajo, via the west fork of the Chama and over pass 8,720 feet	14.5
Along the Rio Navajo	5.5
Thence to the present traveled road	9.9
Thence via the present traveled road, the upper one, to Pagosa	14.5
Total, Conejos to Pagosa	77.4
Distance via the Chama line to Pagosa	114.7
Distance saved by the Chama-Navajo road	37.3

This would bring Pagosa to within 123.4 miles of Fort Garland, and 129.9 from the railroad.

My estimate for the construction of that part of the line from the point of departure from the "Chama" until the "Upper," the present road in use, is reached, a distance, as will be seen above, of 29.9 miles, is as follows:

Rock-blasting, &c.	$3,000
Road embankment and construction, except the above	4,200
Bridge over the main Chama, including crib-work and approaches	725
Bridge over the Navajo	475
Smaller bridges *en route*	625
Contingencies	750
Total	9,775
If the Army ration can be sold at cost price to laborers, deduct one-third	3,258
	6 517

2. THE ALAMOSA LINE

From the present railroad terminus, the shortest most practicable route to Pagosa is in general direction due west, and mainly, of course, a water-line; for in all mountainous regions, particularly a highway, whether a rail or wagon road, must follow lines of drainage for the line of least resistance. Crossing the Rio Grande above the mouth of the Alamosa, continuing on to near the point where it debouches from the mountains to the plain, it thence follows up the cañon of the river. Near the head-waters of the south fork of the river, whose source is to the southwest, this water-line is left and another followed, leading up a tributary to one of the most feasible spots for a pass, for some distance, a depression between two lofty peaks. The range is crossed below timber-line, from which can be followed a tributary flowing due west into the east fork of the San Juan, and in the cañon of that stream and the main river to Pagosa.

This is as direct a route as can be at all economically obtained. Both the La Jara and the Conejos on the Atlantic slope of the San Juan Mountains, each with a general eastern course, were carefully examined, as were also the Navajo and the Blanco, with southwesterly ones on the Pacific side. In whatever way a line be run otherwise than as that described, there are difficulties to be overcome almost insuperable, save at great expenditure. So many streams, main rivers with their tributaries lying oftentimes in deep cañons, intervene on a direct line, that it could be constructed at great cost only, not at all warranted by the necessities of present or prospective commerce or any very material saving in distance.

Taking a bee-line from the railroad to the Rio Grande (where a wagon-road does not exist, but where the railroad line has been located with a view to its probable construction within a year at most), we have the following distances:

	Miles.
Garland City to a point at mouth of cañon of the Alamosa River	52.7
Up the cañon to the mouth of the North Fork of the river	26
Thence up South Fork and tributary to top of range	11
Down a tributary, the East Fork, and main San Juan River to Pagosa	35
Total railroad from Garland City to Pagosa	124.7

A saving of about 5 miles in all, not sufficient to warrant the great excess of expenditure when compared with the Chama-Navajo.

Under the name of the Conejos, Rio Grande and Pagosa Springs Toll-Road Company, four gentlemen, during the past summer, filed the necessary articles of association for the incorporation thereof in the recorder's office at Del Norte, Colo. The papers define their object and designate the route to be "from some point on the Rio Grande up the Alamosa, with a branch to the summit, and up the stream, over the top of the range, and down one of the branches of the San Juan to or near Pagosa Springs"; capital stock fixed at $20,000. None of the incorporators are reported as men of means, or of sufficient enterprise to construct the line, and unless others should take it in hand, the road will not be made. It was doubtless recorded having in view the extension of the railroad west, in which event the toll-road would be a capital investment financially, and their charter, as is often done, might be sold for, probably, a valuable sum.

3. THE SUMMIT LINE.

From Garland, via Del Norte and the summit district, upon the north fork of the Rio Alamosa, near its headwaters, lying in the gulch of the

stream and on the slopes of South Mountain and Mount Belleview, is the mining-district known as the "Summit," thus far exclusively gold, and the finest in the San Juan region. About four and a half miles due west is the summit of the main range, beyond which spring tributaries of the San Juan, their general course hence to Pagosa being southwest. Connecting Del Norte with the summit is an old country road, with its route up San Francisco Creek to its head, thence around and south of the mountain, at the head of the Piedra Pintada, which is designated upon the Hayden maps as Pintada Peak, upon Wheeler's as Del Norte Peak, and is locally known as Old Baldy, thence winding along above timber-line until the north fork of the Alamosa and the summit is reached. Altogether a poor route and a wretched road at its best, it is now in disuse; another and a fine road, upon which toll is taken, is now in operation, saving fully six miles or more in distance. The latter, owned by Mr. John H. Shaw, of Del Norte, follows up the Los Pinos Creek, a natural road, for nearly twelve miles; thence up the mountain-slopes to the southwest, reaching the summit over a few miles of the old line. The toll-road is a very good one, though susceptible of much improvement in grade, location, &c., which would probably be made should there be sufficient increase in travel to warrant it.

From Garland the road is over the San Luis Park or Valley, is generally hard and level, to Del Norte, the Rio Grande being crossed by a bridge seven miles below the town. Distance from the fort, 60 miles; from Garland City, 66.5; from Del Norte to the summit, via the toll-road, it is 27.8 miles, and thence over a trail to Pagosa, 49 miles; making the springs about 77 miles distant, and the total distance from the railroad 143.3 miles, in excess of that by either the Alamosa or the Chama-Navajo lines.

SUMMARY.

This includes all of the short and practicable routes from the East across the range into the Lower San Juan.

From Pagosa to Animas City, a new settlement at the lower end of Animas Park, the distance on the upper road is as follows:

	Miles.
Pagosa Springs to Rio Nutria	13
Thence to Rio Piedra	12.1
Thence to Rio de los Piños	19.9
Thence to Rio Florida	13.6
Thence to Animas City	5.8
Total, Pagosa to Animas City	64.4

From Animas City up the valley, and over the new toll-road in the Grand Cañon of the river opened in the latter part of November, the distance to Silverton is 49.4 miles, making a total from Pagosa of 113.8 miles. With the present situation of the railroad terminus, we have, by the various mentioned lines, the following summary:

Garland City—	To Pagosa Springs.	To Animas City.	To Silverton.
	Miles.	*Miles.*	*Miles.*
Via Ojo Caliente and Tierra Amarilla	258.5	322.9	372.3
Cueva and Tierra Amarilla	228.5	292.9	342.3
The San Antonio route	165.3	229.7	279.1
The Chama route	167.3	231.7	281.1
The Chama-Navajo route	129.9	194.3	243.7
The Alamosa route	124.7	189.1	238.5
The Summit route via Del Norte	143.3	207.7	257.1

EXTENSION OF THE DENVER AND RIO GRANDE RAILROAD.

The proposed extension of the Denver and Rio Grande Railroad west from Garland City will materially change the aspect of affairs. The new terminal point, to be known as Alamosa, will, as I am informed by Col. D. C. Dodge, one of the officials of the railroad company, be on the western side of the Rio Grande, at or near some point on the Rio Alamosa, whence its name is derived, and will be 25½ miles beyond Fort Garland, being an extension of 32 miles. The new line will be entirely straight, and almost a level, and its terminus 33 miles from Del Norte and 28 from Conejos. This will bring the latter place about 24½ miles nearer the railroad than at present, and hence will lessen the distance to all points, including Pagosa, by the several routes passing through it to the same extent; it will diminish the Alamosa line to Pagosa still more, by 32 miles, and will shorten the summit route to the same point by 32½ miles, whence the foregoing table becomes as follows:

From the new railroad terminus, or Alamosa—	To Pagosa Springs.	To Animas City.	To Silverton.
	Miles.	*Miles.*	*Miles.*
Via Ojo Caliente and Tierra Amarilla	234	298.4	347.8
Cueva and Tierra Amarilla	204	268.4	317.8
The San Antonio route	140	205.2	254.6
The Chama route	142.8	207.2	256.6
The Chama-Navajo route	105.4	169.8	219.2
The Alamosa route	92.7	157.1	206.5
The Summit route via Del Norte	109.8	174.2	223.6

The route to Fort Wingate having the choice of two of the above lines will have a corresponding decrease, as follows:

The Wingate crossing of the Chama—	From the railroad or Alamosa.	From Conejos.
	Miles.	*Miles.*
Via the Chama route and Tierra Amarilla	75.2	103.2
San Antonio route	65.2	93.2

THE DEL NORTE AND ALAMOSA RAILROAD.

Some of the citizens of Del Norte, chiefly men of property, conscious of the fact that their town has ceased to largely increase in property, and that unless a new impetus be given to revive business it will soon be outstripped by its more youthful rivals in the mining regions, have formed a company to build and operate a line of rail under the name of the Del Norte and Alamosa Railroad, to connect their town with the terminal point of the Denver and Rio Grande Railroad at Alamosa. I was informed that it would be constructed simultaneously with the extension of the Denver and Rio Grande.

With the railroad at Del Norte, and the toll-road to the summit in good order, the construction of a road thence over the range and down

the San Juan to Pagosa would be most expedient. With a route judiciously selected, the distance might be shortened fully 7 miles, bringing the springs less than 70 miles distant from the railroad.

RECOMMENDATIONS.

With the present situation of the railroad, I would recommend the construction of the Chama-Navajo as of prime importance for the development of the Lower San Juan. Both in a civil and military point of view would it be a most profitable investment. The entire route of travel would be settled upon at an early day, and thriving communities at various points arise, now remote from mails and other facilities. The roving and unsettled bands of Indians in the southwest corner of the State, and in adjoining territory of Utah and Arizona, committing frequent depredations on the whites, will necessitate better protection for the interests of civilization. The present post of Fort Garland, no longer a frontier station, should, in the event of its advancement west, be located somewhere in the Lower San Juan. Communication and lines of supply will necessitate the route via the Chama-Navajo.

The line of the Alamosa road will shorten the distance to Pagosa over the former but about 5 miles, and its cost being more than twice as much, its construction should not be made from any economic consideration. Being, moreover, a line of deep cañons and rocky defiles, no outlying country bordering thereon would be opened up or benefited, as in case of the Chama-Navajo, which is, especially beyond the Chama River, almost wholly a line of valleys. Being a lofty route, it passes over the range, being about 3,000 feet higher than the former, the Alamosa line would be blocked by snow and immpassable for a portion of the year, unless constant traffic prevented. Upon the Chama-Navajo, with its lower situation and protection by sheltering mountains on the north, a natural blockade would not so completely occur.

In the event of the building of the railroad extension to Alamosa, the distance from its terminus to Pagosa by the Chama-Navajo would be 105 miles, and by the Alamosa about 13 miles less. This would be an important saving; but should the track be continued to that point, there is every probability of the construction of the Del Norte and Alamosa Railroad, making Del Norte a terminal point; in this event the summit line to Pagosa assumes the most prominent position, the distance by that route being diminished, as already mentioned, to 70 miles.

The construction of the unfinished link from the summit to the springs, nearly 49 miles by the trail, would entail an expenditure of $18,000. The route will pass down the east fork of the San Juan, where judicious locations will give easy grades, and shorten the line as compared with the present trail, and afterward along the main stream, the whole a cañon region, presenting fewer difficulties of passage than that of the Alamosa. For several miles the main river above the mouth of the West Fork is inclosed in a box cañon, and here would be essential a considerable amount of blasting. Several ranchmen located last summer on the West Fork, in a fine open valley, above its mouth, and thence to Pagosa have made for their accommodation a passable way for light wagons, distance about 11 miles.

C. A. H. McCAULEY,
Second Lieutenant, Third Artillery.

The ADJUTANT-GENERAL,
Department of the Missouri.

From the lower crossing of the Chama, south and west, my prior report describes the first part of the route from this crossing to the south in the language of Lieutenant Anderson:

After leaving the Chama we passed down a trail made by Major Price, Eighth Cavalry, in the summer of 1872. The road at first ascends an arroya, skirting the base of the Gallinas Mountains; then rises a low divide some ten miles distant from the lower ford. The country near the river is furrowed by numerous deep gullies, and produces little else but sage-brush and cactus. At the divide we entered a valley some thirty-five miles in length and from three to twelve miles in width. This valley is bordered on the east by a range of mounts, through which two small streams, the Gallinas and the Copulin, find their way to the Chama. The north end of the range is called Gallinas, the middle section Copulin, and the south end Jemez. They are all covered with evergreens and aspens to their summits, and their more abrupt faces show strata of various colored sandstone. Near the plaza of Nacimiento the Jemez Mountains sent far into the valley spurs of low hills, covered with heavy pine and spruce timber. Between these hills are grass-grown meadows, traversed by clear mountain-streams, bordered with willows. The first of these streams is the Puerco, which, after reaching the main valley, turns to the south and receives the others as tributaries.

The west of this valley is shut in by a range of sandstone mesas from 100 to 500 feet high, showing, in their vertical sides, shales, conglomerates, clays, and various colored strata of friable sandstone. This formation extends down the west bank of the Chama to old Fort Lowell, from a point some twenty miles above it; near that fort it leaves the river and follows down to the west of the Puerco as far as the stage-road crossing, where it apparently ends. Its southern face is seen to the north of the road over its whole length to Fort Wingate. This valley is traversed, longitudinally, from its northern extremity to the head of the Puerco by one principal range, a number of smaller ranges of knife-edge hills of peculiar appearance, sometimes rising to a height of 300 feet. They are formed of a soft, light-gray sandstone, with strata having a dip to westward of near 45°.

The west face has a thin covering of soil supporting a growth of evergreens; the east face is nearly vertical, showing the edges of the strata; the bottom is filled with *débris*.

These ranges are in several places broken through by streams which take their rise at the foot of the mesas on the west, and find their way to the Chama. At the time of our passage they were dry, and to all appearances their principal use was to carry off surface-water. The remainder of the valley is gently rolling. The lower hills are covered with evergreens, and the level spaces between them with a rank growth of sage-brush. The flies were so numerous about these small creeks that we were obliged to go into camp nearly a mile from water, and send down our kegs for a night's supply. Many pieces of both painted and unpainted pottery and some stone arrow-heads were found on mounds of drift, among fragments of quartz and petrified wood, but none were to be seen on the higher hills, nor were they to be found in any numbers on the level plain. Near Nacimiento were several large meadows, supporting fine herds of stock; but little of the ground was under cultivation.

This same portion of the route was examined by Lieutenant Gibbon, Ninth Cavalry, with a special view to making an estimate of the amount of work needed to make it available for freighting purposes. The examination was made in September, 1877, and from Lieutenant Gibbon's report of the 21st September, the following estimate is quoted.

There will be no difficulty in constructing a good road through this portion of the route in from twenty-eight to thirty days with a working force of twenty-five men at the following places:

	Days.
Nutritas to Chama River	2
At Rio Chama	6
Rio Chama to first valley	3
In Keracita Valley and Arroya	2
To second Chipadero Springs	2
At second Chipadero Springs	2
To and over Arroya Blanca	2
Over Butte Hill	3
Ojo San José	3
To Schaap's Ranch	3

In May and June the Rio Chama cannot be forded. An estimate for the cost of a bridge was not made, however. In reducing this estimate to figures it will be recollected that the scene of operations is at a great distance from either Fort Garland or Santa Fé as military stations; that the reduced number of enlisted men for duty in New Mexico makes it entirely unadvisable to recommend their use for this purpose; and lastly, because any miscalculation as to rates of wages to be paid and amount of work done would seriously impair too small an estimate. I summarize the above as 30 men at $1.50 per day for 30 days, equal to $1,350, and adding 10 per cent. for contingencies, $1,485.

On the route there is generally plenty of grass and always plenty of wood. There is plenty of water at the Rio Chama. Ojo San José and the La Jara Pond and a well dug at the Chipadero Springs would probably give a sufficiency of water there.

	Miles.
Tierra Amarilla to crossing of Chama	14½
Crossing of the Chama to North Chipadero Springs	12
Crossing of the Chama to South Chipadero Springs	15
Crossing of the Chama to Butte Hill	24½
Crossing of the Chama to San José Springs	25

Beyond this point no labor is necessary.

From the Chama Crossing to the Puerco Station, on the Santa Fé and Fort Wingate road, the distance is 83 miles. Lieutenant Gibbon's report minutely describes the proposed line of road, and in case an appropriation were made it could be used to much advantage by the person in charge of construction.

From Puerco Station to the west, to Fort Wingate, the regular traveled road gives 102 miles, and cannot probably be shortened or improved much.

To the south, however, a different promise is made. The present road to the southern country and posts strikes the Rio Grande at Albuquerque and follows down that river, which is crossed twice by ferries in order to reach a bad and sandy road on the opposite bank by leaving a worse one on the remaining side. The department commander is fully aware personally of this portion of the road and its character, and it is not necessary for me to dilate more upon it. If freighters were to leave the Wingate road at the crossing of the Puerco and follow down that stream to the Rio Grande, a large part of the sandy road would be avoided, as well as the Albuquerque crossing. An exact description of the characteristics of the Puerco River cannot now be given, but it is hoped to supply this deficiency in the spring. Meantime it is believed that for freighting purposes it is adapted equally as well as the Rio Grande Valley, and if it can be so used it would be advantageous. It is requested that a small sum be asked for a careful survey of this

route, and accordingly an estimate of $1,000 is made. The approximate distance from Puerco Station to the mouth of the stream, or the Rio Grande, is 95 miles.

Inasmuch as present experience indicates decidedly that the progress of railroad building has rapidly and permanently altered freighting conditions in this section of the country, and that the part of wisdom would be to meet this progressive spirit and profit by it, it seems eminently proper to ask for a small contingent fund to repair and construct these new lines when needed. It may be noted that in this country many long roads are rendered useless because they are interrupted during short spaces, which if corrected at slight expense at once there is opened a long and valuable line. I therefore ask for $5,000, or, if the Army ration may be sold to laborers, $3,500 will be sufficient to open or repair military roads in Northwestern Mexico and Southwestern Colorado.

General table of distances from the railroad terminus in Colorado to points in New Mexico.

	Miles.
El Moro to Santa Fé, via Fort Union	221
Garland City to Santa Fé via Taos	146
Saving from latter point	75
El Moro to Fort Stanton via Union	349
Garland City to Fort Stanton via Santa Fé	320
Saving from latter point	29
El Moro to Fort Craig via Fort Union and Albuquerque	381½
Garland City to Fort Craig via Santa Fé and Albuquerque	322½
Saving from latter point	59

To all points to the south of this, Fort Bayard, Fort Selden, and to El Paso, the saving will be the same, *i. e.*, 59 miles.

	Miles.
El Moro to Fort Wingate via Fort Union	391
Garland City to Fort Wingate via Santa Fé	321
Saving from the latter point	70
El Moro to Fort Wingate via Fort Union	391
Garland City to Fort Wingate via Conejos and San Antonio road	294
Saving from the latter point	97

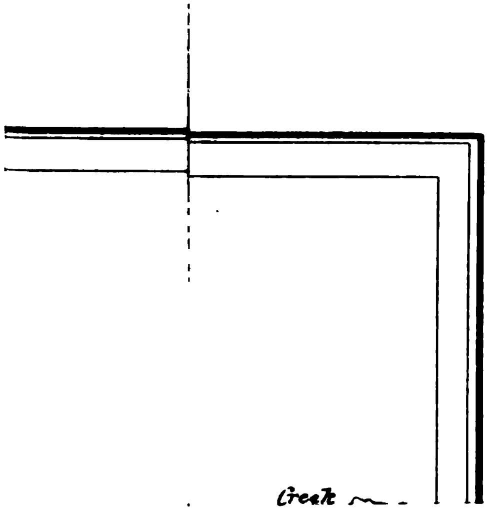
This saving of 97 miles is also effected to all points southwest and west of Fort Wingate, as, for instance, Camp Apache and Prescott, Arizona, in case of the extension of the railroad to Alamosa, which will shortly be done beyond a doubt.

	Miles.
El Moro to Fort Wingate via Fort Union	391
Alamosa to Fort Wingate via Conejos and San Antonio road	271
Saved by the latter route	120

In all probability when the railroad extension reaches Alamosa it will be found desirable to reach Fort Craig and the lower posts from this point by following down the Puerco.

	Miles.
El Moro to Fort Craig via Fort Union and Albuquerque	381½
Alamosa to Fort Craig via Conejos, San Antonio Road, and Puerco River	331½
Probable saving of about	50

This route has advantages which will probably be considered at the time the railroad extension is made.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RECAPITULATION.

Lines of communication between Colorado and New Mexico are important to the military service, and have been radically altered by railroad extension. Improvements should be made to existing roads—

1st. From Fort Garland to Santa Fé, estimate		$10,340
If Army ration sold to laborers	$6,900	....
2d. From Fort Garland to Southwest Chama-Navajo road, new		9,775
If Army ration sold to laborers	6,517	....
Chama Crossing to Puerco Station	1,485	1,485
3d. Survey of line down Puerco River	1,000	1,000
4th. For general use in Southwestern Colorado and Northern New Mexico		5,000
If Army ration sold	3,500	....
	19,402	27,600

The above estimates are considered to be close, and with present prospects an immediate appropriation and application would result in a quick influence on freighting rates, and ease of supplying the entire western and southwestern posts. Throughout this report I have carefully abstained from expressing any views as to the military necessity of this or that road, and trust that this point will be developed by the department commander in forwarding this paper.

I am, sir, very respectfully, your obedient servant,

E. H. RUFFNER,
First Lieutenant Engineers.

THE CHAMA-NAVAJO ROUTE TO THE LOWER SAN JUAN.

Roads are the highways of civilization and are primarily *the* desideratum for the development of country with fine natural resources. The roads of the San Juan country of Colorado are of the first importance, and whatever can be done to shorten the lines of communication and open as yet undeveloped sections will be of the first and most material value.

The recent advance of the Denver and Rio Grande (a narrow-gauge railroad) over the Sangre de Cristo Range has enabled it to control all freight and passenger traffic destined for the San Juan, besides that of all of New Mexico, save the northeastern part. As the lower country of the San Juan is the least favored with respect to outer communication, its claims should be strongly considered. Hemmed in upon the north and east by lofty mountains, with outlying spurs that contain many peaks of great altitude and few practicable or natural passes, the summits of the mountain chains lie approximatively in the arc of a circle, with Pagosa Springs nearly at the center. From its natural position and the relative bases of supply, it becomes a strategic point, and is passed on the upper road to Animas Park and neighboring populated districts.

From the terminus of the railroad at Garland City, the route for all freight and passenger traffic to the Lower San Juan passes Tierra Amarilla, a group of Mexican villages, of which the main plaza is Los Nutritas. The old line by Ojo Caliente and the cut-off by Cueva have been considerably shortened by the construction, during last summer, of a toll-road from Conejos to Tierra Amarilla, which may be known as the "Chama" route, from the stream along whose waters it mainly lies. The road is passable, although 12 miles of the way remain as yet in a bad condition.

Upon another rival line between the same points work has been commenced, but its completion was prevented last fall by the outbreak of the small-pox among the Mexican inhabitants. This is known as the "San Antonio" route, the first part of the line passing mainly along that stream. All roads pass the Chama River at the Mexican plaza of Los Ojos, 2 miles from Los Nutritas; thence to Pagosa the way is almost entirely over a natural road, through low valleys or over gently undulating hills. Beyond the Chama, over the entire route, grass and timber are plentiful; but in July last no running water was found between the Chama and Navajo—33 miles—although frequent rains had but lately fallen. The soil is to some extent alkaline, and upon pools of rain-water camp was dependent. From the Navajo to Pagosa—23 miles—water is abundant, the Blanco and tributaries being crossed *en route*. The saving of distance detween Garland City and Pagosa is, by either the Chama or San Antonio routes, 60 miles, compared with the Cueva line, and 90 less than that via Ojo Caliente. By both the Chama and San Antonio thoroughfares there is required a long and unnecessary detour to the south. Add to this a long march without water, or sole dependence upon capricious rain-storms or pools muddied by sheep-herds, between the Chama and the Navajo, and we find an imperative need of a shorter more direct route, well supplied everywhere with wood, water, and grass. The location found preferable for so desirable a line, a cut-off on the "Chama," may, from its situation, be known as the

CHAMA-NAVAJO.

The great continental back-bone, hemming in upon the north and east the Lower San Juan region, abruptly changes at about latitude 37°, the dividing line of Colorado and New Mexico, from a chain of lofty peaks, with high connecting mountains, to a series of lower ridges with high elevations, detached and at greater intervals. Immediately to its south and at the very base of the Chama peak, whose elevation is 12,200 feet, occurs an exceptionally fine pass fully 3,300 feet below. Watered by the west fork of the Upper Chama, completely protected on the north and east by the mountains and outlying slopes, this mountain valley lies sheltered and warm, covered with nutritious grasses, perfectly adapted and in every respect preferable to any other line to the west. This route leaves the Chama road on the upper part of that river, curves to the south on account of high basaltic mesas on the west bank, ascends the valley of the West Fork, and after passing the divide at an easy grade, descends to the Navajo, down which it follows for about 5 miles. From this river, northwestwardly, at a few miles' distance, tributaries are crossed, whence, after the passage of the main divide between the watersheds of the Navajo and the Blanco, at a short distance, is reached the present "upper road" to Pagosa. On this line the distances are as follows, from Conejos to Pagosa:

	Miles.
Conejos to point of departure from the Chama road	33.0
Thence, via West Fork and pass of 8,720 feet, to the Rio Navajo	14.5
Along the Rio Navajo	5.5
Thence to the "upper" or present traveled road	9.9
Along same to Pagosa Springs	14.5
Total, Conejos to Pagosa	77.4
Distance via Chama line, Conejos to Pagosa	114.7
Distance saved by Chama-Navajo route	37.3

being that amount less than any other short line now open or commenced.

The construction of this line, and its free use by the public, will be of immense benefit to the Lower San Juan. It would open up to settlement magnificent farming and grazing lands now remote from easy communication, and for many other reasons would be a most economic investment of public money. The estimate for its construction from point of departure from the Chama until the upper road is reached, as will be seen above, a distance of 29.9 miles, is as follows:

Rock blasting, &c	$3,000
Road embankment and construction, except above	4,200
Bridge over main Chama, including crib-work and approaches	725
Bridge over the Navajo	475
Smaller bridges on route	625
Contingencies	750
Total	9,775

From the maps accompanying the entire route, with the old and new roads, the advantages of the above saving in distance can be readily noted.

With the present situation of the railroad, we have the following table of distances, showing the great desirability of shorter lines of communication:

Garland City—	To Pagosa Springs.	To Animas City.
	Miles.	Miles.
Via Ojo Caliente and Tierra Amarilla	258.5	322.9
Cueva and Tierra Amarilla	228.5	292.9
The San Antonio route	165.3	229.7
The Chama route	167.3	231.7
The Chama-Navajo route	129.9	194.3

HEADQUARTERS DEPARTMENT OF THE MISSOURI,
OFFICE OF THE CHIEF QUARTERMASTER,
Fort Leavenworth, Kans., January 29, 1878.

SIR: I have the honor to submit, for the information of the department commander, a statement showing the rates paid by the Quartermaster's Department for wagon-transportation from El Moro, Colo., to certain posts in New Mexico and Arizona, during the six months ending December 31, 1877, as compared with the rates to be paid from February 1 to June 30, 1878, under contracts from Garland, Colo., which have been awarded to F. F. Struthy:

From—	To—					
	Santa Fé, N. Mex.	Fort Craig, N. Mex.	Fort Wingate, N. Mex.	Fort Selden, N. Mex.	Fort Bayard, N. Mex.	Camp Apache, Ariz.
El Moro, Colo., six months ending December 31, 1877 (per 100 pounds for whole distance)	$2 05	$3 54	$3 63	$4 33	$5 19	$4 96
Garland, Colo., average of six months ending June 30, 1878 (per 100 pounds for whole distance)	1 55	3 10	3 45	3 75	4 60	4 55
Difference in favor of Garland, Colo. (per 100 pounds for whole distance)	50	44	18	58	59	41

The total quantity of freight transported to these posts yearly is from one to two million pounds, probably nearer two than one million.

Very respectfully,

R. SAXTON,
Chief Quartermaster.

The ASSISTANT ADJUTANT-GENERAL,
Department of the Missouri, Fort Leavenworth, Kans.

[First indorsement.]

HEADQUARTERS DEPARTMENT OF THE MISSOURI,
ASSISTANT ADJUTANT-GENERAL'S OFFICE,
Fort Leavenworth, Kans., January 31, 1878.

Respectfully returned to the chief quartermaster of the department, who is desired to add to the information herein contained a statement of the comparative cost of placing stores at El Moro and at Fort Garland.

By command of Brigadier-General Pope.

E. R. PLATT,
Assistant Adjutant General.

CHIEF QUARTERMASTER'S OFFICE,
DEPARTMENT MISSOURI,
Fort Leavenworth, January 31, 1878.

Respectfully returned to the assistant adjutant-general of the department.

The cost of placing stores at Garland, Colo., is just 20 cents per 100 pounds more than the cost of placing them at El Moro.

R. SAXTON,
Chief Quartermaster.

[First indorsement.]

HEADQUARTERS DEPARTMENT OF THE MISSOURI,
Fort Leavenworth, Kans., February 2, 1878.

This letter, with the accompanying detailed reports, covering fully the entire subject, is respectfully forwarded for the consideration of the Secretary of War.

Garland will undoubtedly be the shipping point for some years of all freight destined for Southwestern Colorado, Eastern Arizona, and the whole of New Mexico, excepting only the posts of Union and Stanton freight rates from Garland, as will be seen, being much below any others offered.

From Garland depart three routes for this service. One to the San Juan country; one to the posts in Arizona, including Fort Wingate, New Mexico, and one via Santa Fé to the Lower Rio Grande. The amount required on each of these roads to make good roads, and thereby still further cheaper freights and facilitate communication, is as follows, viz:

To San Juan country and site of the military post in that region, to which Fort Garland is to be transferred	$11,517
To Fort Wingate and posts in Arizona north of Gila River	2,485
To Santa Fé	10,000
Total	24,002

With this small amount these roads can be put in excellent condition, and there is no doubt that the whole sum will be repaid twice over in a few years by reduction of freight rates. I respectfully ask that the Secretary of War ask a special appropriation for this work of the amount

specified, the work to be done under the charge of Lieutenant Ruffner, chief engineer of this department. The sooner it can be done, the better for the government and all concerned. The great importance of the roads in the settlement and development of the regions which they traverse need not be set forth It will suffice to say that, in my opinion, every interest of the government in that section of the country will be greatly benefited at very small expense in that direction.

JNO. POPE,
Brevet Major-General U. S. A., Commanding.

[Second indorsement.]

HEADQUARTERS MILITARY DIVISION OF THE MISSOURI,
Chicago, February 5, 1878.

Respectfully referred to the chief engineer officer of the division for examination. Please return.

By command of Lieutenant-General Sheridan.

R. C. DRUM,
Assistant Adjutant-General.

[Third indorsement.]

OFFICE CHIEF ENGINEER, MILITARY DIVISION MISSOURI,
Chicago, February 6, 1878.

Respectfully returned to the assistant adjutant-general, Military Division of the Missouri.

G. J. LYDECKER,
Captain of Engineers, Chief Engineer Military Division Missouri.

[Fourth indorsement.]

HEADQUARTERS MILITARY DIVISION OF THE MISSOURI,
Chicago, February 7, 1878.

Respectfully forwarded to the Adjutant-General of the Army.

In the absence of the Lieutenant-General commanding.

R. C. DRUM,
Assistant Adjutant General.

[Fifth indorsement.]

HEADQUARTERS OF THE ARMY,
Washington, February 12, 1878.

Respectfully submitted to the honorable Secretary of War approved.

The completion of the railroad across the Sangre de Cristo Mountains into the valley of the Rio Grande opens up a most interesting and extensive new country. Twenty-four thousand dollars could not be better expended than on the roads herein described, and Captain Ruffner is peculiarly qualified for the work.

W. T. SHERMAN,
General.

HEADQUARTERS DEPARTMENT OF THE MISSOURI,
OFFICE OF THE CHIEF-ENGINEER,
Fort Leavenworth, Kans., February 5, 1878.

SIR: I have the honor to transmit herewith a map of Colorado, with a small portion of New Mexico, showing the general area covered by me during the San Juan reconnaissance, from June to November, 1877.

The lines of communication passable for wagon-trains are marked at all points, whether in the nature of county or private toll-roads. To

complete the scope of this paper as that of a partial report the location of the population has been given. Those portions of the country which have been occupied by settlers for farming, either ranching or grazing, and by prospectors for mining purposes, are also shown, the sections which are thickly populated being so indicated.

Of all the country adapted to agriculture, that drained by the Animas is receiving the largest amount of emigration, the portion known as the Animas Park extending from the mouth of Junction Creek, about 13 miles to the north, an especially beautiful and fertile valley, with an elevation from 6,500 to 6,800 feet, having already been almost wholly occupied. The ranchmen in general, however, have made no improvements worthy of mention on the land, and have done little save to barely establish and hold their claims, for with over ten thousand acres of tillable land, I found last fall the amount under actual cultivation to be less than one-tenth of the total. A few exceptional cases were noted, the ranch of Mr. Lamb, 4 miles above Animas City, deserving especial mention for the fine appearance of his farm, with all the usual outbuildings and external signs of thrift and comfort noticeable in one of the Eastern States.

Animas City referred to is a new and growing town on the right bank of the Animas, just above the mouth of Junction Creek. It is not laid down on any Hayden or Wheeler map, and must not be confounded with the "Animas City" of Wheeler, which is an old deserted place. about 12 miles above, and on the other bank of the river. The opening of the Jicarilla Apache reservation to settlement has, during the past year, drawn a considerable number of emigrants to the San Juan, the Lower Animas, and the La Plata.

The farming and grazing population established themselves on the lower parts of rivers and streams, and are permanently thereon; the mining-camps, wholly or almost entirely, are located at the headwaters of streams or upon mountain-peaks near by. Owing to the short working-season, and the intense severity of the winter at that elevation, the mining-population is of a semi-permanent nature, leaving about the latter part of October, and returning in May or June, from the towns or the lower regions, where they congregate for the winter. As an illustration of the brevity of the working-season may be mentioned my visits to the Summit, a gold-mining district southwest of Del Norte. They were three in number, and from different directions, during the reconnaissance: in June, from the Lower Alamosa; in August, from Pagosa, via the San Juan; and in October, from Del Norte. In August only was my way not impeded by snow; the total precipitation there for the year ending November 1 being 24 feet. In preparing the printed table of densest populated districts attached to the map, the population belonging to various mining-camps has been so accredited, since it there properly belongs, and with other of a floating nature, fully aggregates the numbers given. While there may be a percentage of error in the designated numbers in a few instances, it is, on the whole, believed to be less than the total of all the region visited from the existence of obstacles to an exact and actual count. The difficulties of arriving at a thorough and perfect census in such localities may well be imagined, for while a town is drained of its winter population for the mining regions, prospectors distribute themselves through localities almost uninhabited, or waver from one section to another as its prospects change. There were, for instance, from three to four hundred more persons in Lake City last spring than are so credited, owing to their temporary stay; immigration was very great to this locality, but

disappointed in endeavors to find employment, they either returned or spread out into new districts.

The total distance traveled, after leaving Fort Garland, Colorado, was 2,030 miles; this was wholly in the field, mainly with pack-trains, and is confined to that made in person, not including any mileage made by detached wagon-trains or by any members of my party unaccompanied by myself.

The following table gives the distances between interesting or important points visited:

Between what points.	Miles.	Remarks.
Garland City to Fort Garland	6.5	Railroad terminus at Garland City.
Fort Garland to Stewart's Ferry	19.5	Stewart's, or upper ferry, on the Rio Grande.
Stewart's Ferry to Conejos	26.5	
Fort Garland to Chevez Ferry	31.5	Chevez, or lower ferry, formerly Myers's.
Cheves Ferry to Conejos	18	
Conejos to Tierra Amarilla (Las Nutritas) via Ojo Caliente	150	
Conejos to Tierra Amarilla (Las Nutritas) via Cueva	120	
Conejos to Tierra Amarilla (Las Nutritas) via the Chama route.	60.7	
Los Nutritas to Los Ojos	2	Chama River forded at Los Ojos.
Los Ojos to Rio Navajo	33.2	Upper road to Pagosa.
Rio Navajo to Rio Blanco	12.3	
Rio Blanco to Pagosa Springs	10.6	
Conejos to Pagosa via Ojo Caliente	208	County-road; lower route.
Conejos to Pagosa via Cueva	178	County-road; cut-off.
Conejos to Pagosa via the Chama route	114.8	New toll-road; 12 miles incomplete.
Conejos to Pagosa via San Antonio route	112.8	New toll-road; constructing.
Conejos to Pagosa via Chama-Navajo route	77.4	Proposed United States road; the shortest route West.
Pagosa Springs to the Summit District	49	Trail up Rio San Juan.
Pagosa to Rio Nutria (spring near ranch of Colonel Pfeiffers).	13	County-road.
Rio Nutria to Rio Piedra	12.1	
Rio Piedra to Rio de los Pinos	19.9	
Rio de los Pinos to Rio Florida	13.6	
Rio Florida to Rio de los Animas	5.8	
Animas City to Parrott City	19.5 18.1	Via toll-road. Via trail.
Parrott City to East Fork Rio Mancos	11.9	County-road.
East Fork to West Fork Rio Mancos	.7	
Thence to Big Bend Rio Dolores (Camp 64, September 23)	18.7	Trail.
Parrott City to mouth Rio La Plata	54	Toll-road.
Animas City to mouth Rio de las Animas	58.5	Trail.
Animas City to Hermosa	8.6	County-road.
Hermosa, via Grand Cañon of the Animas, to Silverton	40.8	Wightman's new toll-road.
Silverton to Howardsville	4.7	County-road.
Howardsville to Lake City, via Animas Forks and Burrow's Park.	36.6	Toll road.
Howardsville to Lake City, via Mineral City and Hensen Creek.	31	
Howardsville, via old wagon-road, to Carr's	16.3	Summit of pass, 12,400 feet.
Howardsville, via Cunningham Gulch and trail over Summit, to Carr's.	22.7	Pass, 11,900 feet.
Carr's to Alden's Junction or Antelope Springs	27	
Alden's to Lake City	33.5	Toll-road; pass, 11,100 feet.
Alden's or Antelope Springs to Wagon-Wheel Gap	16	Toll-road down Rio Grande.
Wagon-Wheel Gap to mouth South Fork Rio Grande	11.6	
Thence to Del Norte	15.8	
Del Norte to the Summit	27.8	Toll road.
·l Norte to Fort Garland	60	County-road.
Norte to Piedra Pintada	15.9	In San Luis Park; county-road.
..nce to La Jara post-office on Rio de la Jara	18.6	
Thence to Conejos	13.5	

I am, sir, very respectfully, your obedient servant,

C. A. H. McCAULEY,

Second Lieutenant Third Artillery,

Assist. to Chief Engineer Dept. of Mo.

Assistant ADJUTANT-GENERAL,

Department of the Missouri, Fort Leavenworth, Kans.,

Through Chief Engineer.

[Indorsement.]

HEADQUARTERS DEPARTMENT OF THE MISSOURI,
OFFICE OF THE CHIEF ENGINEER,
Fort Leavenworth, Kans., February 8, 1878.

Respectfully forwarded.

Particular attention is invited to this report, as it contains, in brief, much valuable information, collected with care and condensed with judgment.

The map of the whole of Colorado is furnished, so that a comparison may be readily made of the area reconnoitered with that of the whole of the State. In future reports on this subject a partial map will be prepared of the area in question and the whole State will not again be represented.

E. H. RUFFNER,
First Lieutenant Engineers.

HEADQUARTERS DEPARTMENT OF THE MISSOURI,
Fort Leavenworth, Kans., February 11, 1878.

Respectfully forwarded to the assistant adjutant-general, headquarters Military Division of the Missouri, in connection with the report on the same subject transmitted on the 2d instant.

These reports contain, as it appears to me, all the information necessary to determine, within limits, the location for a consolidated Ute reservation and agency and the military post needed in the San Juan country.

JNO. POPE,
Brevet Major-General, U. S. A., Commanding.

HEADQUARTERS MILITARY DIVISION OF THE MISSOURI,
Chicago, February 15, 1878.

Respectfully forwarded to the Adjutant-General of the Army.

In the absence of the Lieutenant-General commanding.

R. G. DRUM,
Assistant Adjutant-General.

HEADQUARTERS OF THE ARMY,
Washington, February 19, 1878.

Respectfully submitted to the Secretary of War, in connection with previous papers referred to by General Pope, which were submitted on the 12th instant.

W. T. SHERMAN,
General.

45TH CONGRESS, 2d Session. } HOUSE OF REPRESENTATIVES. { Ex. Doc. No. 67.

LOSS OF THE DREDGE-BOAT McALESTER.

LETTER

FROM

THE SECRETARY OF WAR,

IN RELATION TO

The disappearance of the United States dredge-boat McAlester.

MARCH 13, 1878.—Referred to the Committee on Commerce and ordered to be printed.

WAR DEPARTMENT,
Washington City, March 13, 1878.

The Secretary of War has the honor to report to the House of Representatives, for the information of the Committee on Commerce, in response to telegram from the chairman of said committee, that the United States dredge-boat McAlester left New Orleans January 2, 1878, for Sabine Pass, Texas, and has not been heard from since. She is undoubtedly lost.

The accompanying copy of a letter from Capt. C. W. Howell, Corps of Engineers, and inclosed list, gives the names, occupation, and wages of the persons employed on the dredge-boat.

GEO. W. McCRARY,
Secretary of War.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., March 7, 1878.

GENERAL: In compliance with telegram from the Chief of Engineers, dated March 6, 1878, I have the honor to forward herewith list of names, occupation, and monthly wages of employés lost on the United States dredge-boat McAlester.

Very respectfully, your obedient servant,

C. W. HOWELL,
Captain of Engineers, U. S. A.

Brig. Gen. A. A. HUMPHREYS,
Chief of Engineers, U. S. A., Washington, D. C.

List of names, occupation, and monthly wages of employés lost on United States dredge-boat McAlester.

Name.	Occupation.	Monthly wages.
L. E. Swift	Master	$125 00
I. Warren	Mate	125 00
Warren C. Beaver	Purser	60 00
Joseph K. Heap	First assistant engineer	125 00
B. J. Collins, sr	Second assistant engineer	100 00
J. Levanga	Third assistant engineer	90 00
George Brooks	Fourth assistant engineer	80 00
Leonard Gish	Water-tender	55 00
T. Cronian	Oiler	50 00
D. Finn	do	50 00
William Ryan	Fireman	50 00
M. McGnosan	do	50 00
Frank Sherry	do	50 00
T. Oliver	do	50 00
P. Rogers	do	50 00
Pat. Kennedy	do	50 00
Samuel Guthrie	Coal-passer	40 00
M. Man	do	40 00
James Carline	do	40 00
H. Brooks	do	40 00
B. Collins	do	40 00
J. Hughes	do	40 00
M. Burgot	Cook	50 00
Paul A. Poujal	Assistant cook	30 00
James Patterson	Seaman	40 00
T. Casey	do	40 00
J. Burk	do	40 00
Henry McDermott	do	40 00

O

45TH CONGRESS, 2d Session. } HOUSE OF REPRESENTATIVES. { Ex. Doc. No. 68.

CERTIFICATES OF CITIZENSHIP TO SEAMEN DURING YEAR ENDING DECEMBER 31, 1877.

LETTER

FROM

THE SECRETARY OF STATE,

TRANSMITTING

An abstract of returns made by collectors of customs, of the number of seamen having received certificates of citizenship during the year ending December 31, 1877.

MARCH 20, 1878.—Referred to the Committee on Commerce and ordered to be printed.

DEPARTMENT OF STATE,
Washington, March 11, 1878.

SIR: In compliance with section 207 of the Revised Statutes, I have the honor to transmit an abstract of the returns made to this department by collectors of customs, pursuant to section 4591, of the said Statutes, showing the number of seamen registered as having received certificates of citizenship during the year ending December 31, 1877.

I have the honor to be, sir, your obedient servant,

WM. M. EVARTS.

The Hon. S. J. RANDALL,
Speaker of the House of Representatives.

[Inclosure.]

Abstract of returns of collectors of customs, showing the number of seamen registered as having received certificates of citizenship during the year ending December 31, 1877.

State.	District.	Collector.	Number of seamen registered.	
			Native.	Naturalized.
Massachusetts	Edgartown	C. B. Marchant	3	None.
Do	Marblehead	Simeon Dodge	1	Do.
Rhode Island	Newport	S. W. Macy	3	Do.
Do	Gloucester	F. J. Babson	None.	Do.

NOTE.—No reports were received from any other collectors.

45TH CONGRESS, 2d Session. } HOUSE OF REPRESENTATIVES. { Ex. Doc. No. 69.

KING VICTOR EMANUEL I, OF ITALY.

LETTER

FROM

THE SECRETARY OF STATE,

TRANSMITTING

A letter from the Italian minister concerning the marks of respect shown to the memory of Victor Emanuel I, late King of Italy.

MARCH 25, 1878.—Ordered to be printed.

DEPARTMENT OF STATE,
Washington, March 22, 1878.

SIR: Pursuant to the request of Baron Blanc, envoy extraordinary and minister plenipotentiary of His Majesty the King of Italy, I communicate a translation of a note of the 4th instant, addressed by the baron to this department, expressing the gratification of his sovereign with the participation of the various branches of this government in the obsequies of the late King Victor Emanuel I, and with the regret generally shown in this country upon the demise of that monarch.

I have the honor to be, sir, your obedient servant,

WM. M. EVARTS.

The SPEAKER *of the House of Representatives.*

Inclosure.

A translation of a note from Baron Blanc.

LEGATION OF ITALY IN THE UNITED STATES,
Washington, March 4, 1878.

MR. SECRETARY OF STATE: I am instructed to convey through you the expression of the gratitude of His Majesty the King, my august sovereign, to His Excellency the President of the United States for his presence at the funeral service that was held at Washington in memory of King Victor Emanuel I.

I have also received instructions to inform you how deeply my government has been touched by the part taken in this ceremony by the Cabinet, the Senate, the House of Representatives, the Supreme Court, the Army, the Navy, and other distinguished bodies.

The private testimonies have also been highly appreciated which have been rendered by the American people on this painful occasion to the Italian nation, and which have been shown in so lofty a form, among others, in a beautiful poem by Mr. Bayard Taylor, which has been placed in the hands of His Majesty.

These noble manifestations of sympathy with the grief that has afflicted the royal family and the Italian nation have met with an echo of gratitude and affection in Italy, and the exchange of such sentiments cannot fail to draw still closer the bonds which unite the two countries.

I should be obliged to you, Mr. Secretary of State, if you would be pleased to transmit this expression of thanks to the presiding officers of both houses of Congress, to the officers of the Army and Navy, and to the other dignitaries whom I cannot address directly.

I avail myself of this occasion to renew to you, Mr. Secretary of State, the expression of my very high consideration.

BLANC.

His Excellency WM. M. EVARTS,
Secretary of State, &c.

5TH CONGRESS, } HOUSE OF REPRESENTATIVES. { EX. DOC.
2d Session. } { No. 70.

APPOINTMENT OF CADETS BY THE PRESIDENT.

LETTER

FROM

THE ATTORNEY-GENERAL,

IN RESPONSE TO

A resolution of the House of Representatives, in reference to the appointment of cadets to the Naval and Military Academies by the President.

MARCH 28, 1878.—Laid on the table and ordered to be printed.

DEPARTMENT OF JUSTICE,
Washington, March 27, 1878.

SIR: I have the honor to acknowledge the receipt of the following resolution, dated March 16, 1878:

Resolved, That the Attorney-General of the United States be requested to inform the House of Representatives whether, in his opinion, the annual appointments of ten cadets at large made by the President of the United States respectively to the Military Academy and Naval Academy have been made in pursuance of law or by custom, and, if by custom, how long it has been construed as establishing such power of appointment.

I understand that the object of this resolution is not to elicit the facts connected with the appointments referred to in it, as, if so, it would no doubt have been addressed to the War Department, the means of obtaining such facts being there and not in this department.

It is therefore desired, as I understand, that I should render a legal opinion upon the subject to which the resolution refers.

In that view, I must reply that I am not at liberty to furnish the legal opinion contemplated. The authority of the Attorney-General to render his official opinion is limited by the laws which create and define his office, and does not permit him to give advice at the call of either house of Congress, or of Congress itself, but only to the President or the head of an executive department of the government. The absence of authority to respond to calls for legal opinions, coming from sources other than those prescribed by law, was, early in the history of the government, suggested to the House of Representatives by the then Attorney-General, Mr. Wirt (1 Op., 335), and no change in this respect has been made by the law creating the Department of Justice. The view thus taken has been invariably observed by my predecessors, including Attorneys-General Taney, Crittenden, Bates, Evarts, and Williams. (2 Op., 499; 5 Op., 561; 10 Op., 164; 12 Op., 544; 14 Op., 17; 14 Op., 177.)

I therefore feel that neither my high respect for the express wish of your honorable body, nor my earnest desire to comply with any request that it might make, would warrant a departure in the present instance from the law and precedents which have heretofore been established.

Very respectfully, your obedient servant,

CHAS. DEVENS,
Attorney-General.

The SPEAKER *of the House of Representatives.*

ADOPTION OF METRICAL SYSTEM.

LETTER

FROM

THE SECRETARY OF THE TREASURY,

IN RESPONSE TO

A resolution of the House of Representatives, transmitting certain reports in reference to the adoption of the metric system.

MARCH 28, 1878.—Referred to the Committee on Coinage, Weights, and Measures.

MARCH 29, 1878.—Recommitted to the Committee on Coinage, Weights, and Measures and ordered to be printed.

TREASURY DEPARTMENT, *March* 26, 1878.

SIR: I have the honor to acknowledge the receipt of House resolution of November 6, 1877, asking that the heads of the executive departments of the government be requested to report to the House of Representatives, at as early a date as practicable, what objections, if any, there are to making obligatory in all governmental and individual transactions the metrical system of weights and measures, whose use in the United States has been authorized by act of Congress, and also how long a preliminary notice should be given before such obligatory use can be introduced without detriment to the public interests, &c.

Concerning this matter of inquiry, I am of the opinion that it is not advisable to make the metrical system of weights and measures obligatory in any transactions at present. The law now legalizes and permits that system to be adopted in all cases with the consent of parties.

While the metrical system is undoubtedly the more perfect in theory the old system of weights and measures is so ingrafted upon the business habits of our fellow-citizens, that a new system should not be adopted until it is well understood and acquiesced in by the body of the people. I think great confusion, many inconveniences, and much litigation would arise from its hasty adoption. Congress might properly, in any revision of the tariff, adopt this system, stating in the law, however, the equivalents of the old in the metrical system; but even this change would create some embarrassment, and is of doubtful utility.

I submitted the resolution, however, to the Superintendent of the Coast Survey, the chief clerk of the department, and the chief clerk of the Bureau of Statistics, for an expression of their respective views on

the matter, and I transmit herewith their replies, to which attention is respectfully invited.

Very respectfully,

JOHN SHERMAN,
Secretary.

Hon. SAMUEL J. RANDALL,
Speaker of the House of Representatives.

Reply of J. K. Upton, chief clerk of Treasury Department.

TREASURY DEPARTMENT,
OFFICE OF THE SECRETARY,
Washington, D. C., March 6, 1878.

SIR: In compliance with your verbal request that I present to you, in writing, any suggestions that may occur to me in the matter of the proposed introduction, into this country, of the metric system of weights and measures, that the same may be transmitted to Congress with your reply to the resolution of the House of Representatives, dated November 6, 1877, I have the honor to submit the following:

PRESENT STANDARDS.

The necessity of uniform standards for measuring distances, weights, capacity, and values, among people intimately associated is universally acknowledged, and the Constitution of this country has wisely given to Congress the power to fix these standards. This power has not been freely exercised and consequently there is no uniform or authoritative standards of measurement throughout the country.

In measuring length, the yard, derived from ancient arbitrary standards of England, is an accepted standard. In scientific theory this yard is supposed to rest upon a law of nature. The inch, the $\frac{1}{36}$ of the yard, is said to be contained 39.13929 times in the length of a pendulum that in a vacuum, and at the level of mid-tide in the latitude of London, vibrates seconds. It is, in fact, the distance between two points on an actual bar of brass which the law has declared to be a yard, the distance to be taken when the temperature of the bar is at 62° Fahrenheit. This bar was obtained from England in 1827 for the survey of the coast, and is deposited in the office of the Coast Survey in this city. On it has been copied the standard English yard, and it affords a standard which has been adopted by the executive departments of the government and by the several States for all purposes of linear measurements. In practice the yard is variously subdivided and other derivative standards employed.

In the actual government standards at the custom-houses, the yard is divided into tenths and hundredths. Surveyors and engineers employ neither the yard nor the inch, but the foot, the one-third of a yard, and its decimal subdivisions. Mariners measure by the cable-length (240 yards), and fathom (6 feet). Land-surveyors employ the chain (22 yards), and the link (7.92 inches). Artificers and architects reckon by the foot and the inch, subdivided into halves, quarters, and eighths. Muslins and dry-goods generally are measured by the yard, subdivided into halves, quarters, and eighths; clock-pendulums by the line ($\frac{1}{12}$ of an inch) and the point ($\frac{1}{72}$ of an inch), and the height of horses is measured by the hand (4 inches).

In measuring weight, the standand for coinage purposes is the troy pound. Like the yard, it is derived from arbitrary standards of England. In 1827 Congress declared a certain brass weight, procured that year by the minister of the United States at London, to be the standard troy pound of the Mint of the United States, conformable to which the coinage of the country should be regulated. This pound weight is identical with the troy pound of England. It is assumed to contain 5,760 grains, and investigation shows that 252.458 of these units in brass will be in just equilibrium with a cubic inch of distilled water when the mercury stands at 30 inches in a barometer, and in a thermometer of Fahrenheit at 62°, both for the air and water. A pound avoirdupois contains 7,000 of these grains.

Copies of both pounds have been furnished the several States and adopted by them as standards, thus securing uniformity in standard units of weight. The troy pound used in weighing precious metals is subdivided into the ounce (480 grains), the pennyweight (24 grains), and the grain also is subdivided decimally. Apothecaries, in compounding medicines, employ the scruple (20 grains), and the dram (60 grains); but in all ordinary commercial transactions the pound avoirdupois is employed, being subdivided into the ounce (437.5 grains) and the dram (27.35 grains); the ounce being also by usage subdivided into halves and quarters.

A weight called a quarter, consisting of either 25 or 28 pound units is also used, and a hundred weight is 100 or 112 pound units, and a ton 2,000 or 2,240 pound units, according to the substance weighed, and the party weighing it. Coal, for instance, is purchased by the ton of 2,240 pounds and sold by the ton of 2,000 pounds.

In measuring capacity, three units, also adopted from England, are employed—the bushel, the wine-gallon, and the beer-gallon For measuring fruits, grain, salt, &c., the bushel (2150.42 cubic inches) is used, subdivided into the peck (537.06 cubic inches), the gallon (268.8 cubic inches), the quart 67.02 cubic inches), and the pint, ½ of a quart. This bushel is identical with the old Winchester bushel. The imperial bushel of England now used in that country is equal to 1.03152 of the Winchester bushel. The value of a bushel as a unit of weight will be hereafter considered.

For measuring liquids, except ale, beer, and milk, the wine-gallon, containing 231 cubic inches, is used. It is subdivided into fourths, called quarts, these quarts into halves, called pints, and the pints into fourths, called gills. There is also in this system a barrel of 31.5 gallons, a tierce of 42 gallons, and a tun of two pipes.

For measuring ale, beer, and milk, the beer gallon, 282 inches, is the unit, divided, like the wine-gallon, into quarts and pints. There is also in this measure the barrel of 36 gallons, the hogshead of 54 gallons, the puncheon of 72 gallons, and the butt of 108 gallons. None of these units are identical with any units of the other capacity measures. To add to the confusion, there are in different parts of the United States a barrel for beer, consisting of 32 gallons; the barrel for corn, of 5 bushels; for fish, of 220 pounds; for flour, 196 pounds; for lime, 320 pounds; and for lamp-oil, 43 gallons. The imperial gallon used in Great Britain contains 277.274 cubic inches, thus differing in size from any gallon used in this country.

In measuring solids, ordinarily the cubic inch, foot, and yard are used as units. In measuring round and hewn timber, tons of 40 and 50 cubic feet are respectively used. For shipping purposes, a ton of 42 cubic feet

is used; and in measuring wood, the cord-foot (16 cubic feet) and the cord (128 cubic feet) are employed.

Appended to this report are tables, marked "A, B, C," showing the units of each measure and their values in terms of a common unit of the system to which it belongs, and also their equivalents in terms of the metric system.

It will be seen that, in measuring length, twenty-five units are employed, three of which, although under different names, have like values, the others having different names and values, but bearing no useful relation to each other. In measuring-weights, eighteen units are employed, three of which are duplicated, as the troy pound, the apothecaries' pound, and the avoirdupois pound, which are identical in weight; others have the same name but are of different values. Those duplicated reduce to that extent the number of units for the several purposes, but the fact of their duplication confuses rather than simplifies the system.

In the measurement of capacity, twenty-seven units are employed, though but nineteen have different names. None of these are duplicated, however, except in names; and the gallon has three distinct values, so also have the quart and pint. The bushel appears to have but one value, but in nearly every State and in the customs-tariff of the general government the term is also employed as a unit of weight, the law fixing the number of pounds according to the substance weighed. Table D, herewith appended, shows the value of the bushel under the laws mentioned, prepared from latest information accessible. It will be seen that the most common products of the earth have no uniform standard of measurement. In the contiguous States of Massachusetts, Connecticut, and Rhode Island, a bushel of oats, for instance, is, respectively, 32 pounds, 28 pounds, and 2150.42 cubic inches, and like confusion exists throughout the country.

As no trade restrictions exist between the several parts of the country, the disadvantage of having so common a standard as the bushel mean one thing in one State and another in another is easily seen. But even in local transactions one meets with troy weights, apothecaries' weights, and avoirdupois weights; with long tons, short tons, and shipping tons; with wine gallons, beer gallons, and dry gallons, and with barrels of undefined sizes, making in all an aggregate of appalling confusion.

A system consisting of a single unit for each measure, bearing simple relations to each other and having uniform subdivisions and multiples, would evidently be far superior for all purposes of measurements, local or throughout the States, and if superior for local and national use, it would also be preferable for international purposes, if, at the same time, it should be in harmony with the systems of other countries.

THE PROPOSED STANDARDS.

After several years of investigation, in 1795 France invented and adopted a system under which, for everything susceptible of being measured and weighed, there should be only one measure of length, one of weight, and one measure of contents; their subdivisions and multiples to be expressed decimally, and all to repose for verification upon a unit of length, which should be an aliquot part of the circumference of the earth. To obtain such a unit, measurements of an arc of a meridian were made, and the length of the quadrant meridian having been obtained, its one ten-millionth part was adopted for the purpose. This unit, equivalent to 39.37 + English inches, is called the *meter*, upon which are based all other measures constituting what is known as the "metric system."

The *gram* is the unit of weight, and is the weight of a cube of water of maximum density, each edge of the cube being $\frac{1}{100}$ of the meter.

The *liter* is the unit for measuring capacity, and is equal to the contents of a cube whose edge is the tenth part of the meter.

The *are* is the surface measure, equal to a square whose side is 10 meters.

The *stere* is a cubic meter used in measuring certain solids.

Each of these units is divided decimally and larger units are formed by proceeding decimally. The subdivisions are designated by the prefixes *deci*, *centi*, and *milli*, and the successive multiples by *deka*, *hecto*, *kilo*, and *myria*, each having its own significance and no other.

The adoption of this system in the United States is now proposed. Compared with our existing systems, its superior advantages would seem to consist (1) in having an invariable standard taken from nature; (2) in having a single unit for all weights and a single unit of measures of capacity for all substances, wet or dry; (3) in having decimal subdivisions and multiples of its units; and (4) in the uniformity, precision, and significance of its nomenclature.

(1.) The only advantage of having the unit an aliquot part of the earth's polar circumference would appear to be in its application to geography and astronomy. But the dividing of the quadrant of the meridian decimally into hundreds and thousands, as proposed, has been found impracticable and the project has been abandoned. To that extent the metric system has proven a failure. Recent experiments have also demonstrated that the length of the quadrant meridian was not accurately ascertained at the time of the adoption of the metric system, and consequently the actual meter established is not the aliquot part of the meridian, as supposed. Future investigations may eliminate other errors of calculation and again change the theoretic standard. For all practical purposes a platina rod kept in Paris is the standard meter, and it has no special advantage over that of the brass rod kept in London for a standard yard.

(2.) In having one unit for weights and one unit for all measures of capacity, the metric system enjoys a superiority over all others. To the English system belongs two measures of weight, the troy pound and the avoirdupois pound; and three measures of capacity, the wine-gallon, the beer-gallon, and the bushel, containing eight dry gallons. This diversity of measures originated in an effort to make a measure of capacity also a measure of weight; for instance, a gallon of wheat and a gallon of wine each to weigh eight pounds avoirdupois. But the effort failed, and the law long ago fixed the dimensions in cubic inches only.

The metric system has only one measure of weight and one measure of capacity, and experience has proved these to be sufficient for all purposes desired.

(3.) To the English system belongs also the disadvantage of an irregular scale of progression between units of the same measure. In measures of length, we ascend by the factors 12, 3, 5½, 40, 8, 3, or else by 7.95, 25, 4, and 80. In weights we have three series, avoirdupois, troy, and apothecaries, the common unit being the grain. In the first, the factors are $27\frac{11}{32}$, 16, 16, 25 or 28, 4, and 20; in the second, 24, 20, and 12; and in the third 20, 3, 8, and 12. The factors in other measures are equally as various. To learn these many scales of unequal progression requires much time and labor, which can be better applied to other purposes.

In the metric system, however, we ascend and descend in all cases by the common factor 10, thus placing the system for all purposes of cal-

culations upon the basis of simple numbers. The decimal system in numeration has already asserted and maintained itself, and to it has given way one by one the schemes of different nations. In countries where not adopted it is frequently used. Even in England, where pounds, shillings, and pence constitute the currency of the country, merchants count in cents their interest, discount, and dividends. Slowly, but surely, all standards of measurement are in practice being divided into tenths and hundredths. The decimal system, once adopted, has in no instance been abandoned; and whether we will or not, it will ultimately prevail to the displacement of all other systems.

(4.) In the English system of weights and measures there are also found 74 units in common use, having 56 names. The ounce, the dram, and the grain are indefinite parts of an indefinite whole. The pound avoirdupois is heavier than the pound troy, but the ounce avoirdupois is lighter than the ounce troy. In the confusion numbers even lose their identity. A dozen, for instance, may mean sixteen; twenty-eight signify twenty-five; and one hundred and twelve a hundred; thus making the whole less than the sum of its parts. A gallon of wine is not so much as a gallon of milk, and a ton of coal is sometimes one weight and sometimes another. The bushel for measuring products of the earth has 130 different sizes in this country, and none of them of the size of the bushel of England, to which country most of our surplus products are shipped in quantities measured by bushels.

In the vocabulary of the metric system there is but one word to denote a unit of length, one to denote a unit of weight, one for a unit of capacity, one for surface, and one for cubic measurements, and the words have no other significance. Thus the word meter means an established unit of length and nothing else. It cannot be the measure of one length in one country and of another length in another country. The gram is a specific weight everywhere and under all conditions the same, and the *liter* denotes a vessel of specific cubic contents for the measurements of all liquids, and is never used for any other purpose.

The multiples of these units are denoted by prefixing to them respecttively four syllables from the Greek language, indicating decimal progression. The subdivisions, by prefixing four syllables from the Latin language, indicating decimal fractions, and thus, five words indicating units and seven prefixes indicating numbers, make up the vocabulary of the system. Of whatever superiority, however, the metric system may be possessed to make its use obligatory by law for public purposes and in transactions between individuals will be a harsh exercise of legislative authority.

Weights and measures have been aptly ranked as necessities of life, and no system of them, however objectionable, can be wholly eradicated, except by long periods of time.

Appalled at the prospective confusion which the abolition of our existing system would bring into every household in the land, John Quincy Adams, after an exhaustive review of the whole subject, advised Congress in 1821 to take no steps with a view of such abolition, and, while he eulogized in glowing terms the merits of the metric system, he could only recognize the system as an experiment, and its adoption at best, a matter of doubtful expediency. Since that day, nation after nation has, by imperative law, abolished its system of weights and measures, and substituted the metric system with only the best results. Throughout the civilized world, and even in pagan lands, this system has found recognition and welcome. At the risk of tediousness, I beg to set forth in detail a statement showing its wonderful expansion.

AMERICA.

ARGENTINE REPUBLIC.—(*Until* 1828 *with Uruguay.*)—The metric system of weights and measures introduced for customs purposes, according to the customs-tariff laws of 7th October, 1872, and 11th October, 1873, and is used in the assessment of duties.

BOLIVIA, REPUBLIC OF.—(*Once South Peru.*)—Weights and measures the same as in Peru, which see.

The coin-weight, at least, since 1871, is the French gram.

BRAZIL.—(*Rio de Janeiro and Pernambuco.*)—Since January 1, 1874, the weights and measures of Brazil are the French metric.

An imperial decree of 26th July, 1872, approved a law voted by both chambers upon the introduction of the metric system, which, after a permissive use of *ten* years, should be generally in force. According to a decree of 18th September, 1872, the new system went into obligatory effect, with 1st July, 1873, a delay of half a year, however, to be allowed for the execution of the decree; therefore, with the 1st of January, 1874, the metric system is definitely established with all its consequences, and since this time, only metric measures and weights are used. Diamonds, however, are still permitted to be sold according to the old Portugese *outava.*

The French meter has already for many years been commonly employed for manufacture, but often, as *now*, the English yard is used, and sometimes the old Parisian *aune.* Stone coal is sold, at wholesale, by the English ton of 2,240 pounds, avoirdupois—the *tonelada*—reckoned equal to 70 arrobas, old weights; so also, bone ashes; also, ships' freights are, for the most part, settled according to the English ton.

The interval from the date of the decree of 26th June, 1862, introducing the system, to that of 18th September, 1872, declaring the use of the system obligatory, is nine and two-thirds years; from the earlier date to 1st July, 1883, is eleven years, and to 1st July, 1874, the date from which its use is obligatory, twelve years.

CHILI, REPUBLIC OF.—(*Santiago de Chili.*)—A law of 29th January, 1848, introduced the French metric system of weights and measures. For coin-weight the system came at once into use, but for other purposes its enforcement was delayed.

By a decree of the President of the Republic of 31st May, 1862, and a decree of the administration of 19th December, 1862, the system came into force for customs purposes from 1st January, 1863.

The interval from the date of the law introducing the system to its enforcement for customs purposes was fifteen years.

In trade and for the purposes of common life the old system is generally employed.

Silk and woolen goods are sold by the *vera*; sugar by the *arroba.* Stone coal is sold by the ton (tonelada) of 1,000 kilograms; copper ore by the 100 kilograms; pig-iron is sold by the Spanish ton (tonelada) of 20 quintales (920 kilograms); so also, is guano.

COLOMBIA, *in its broader sense.*—(*Republic of Colombia*, 1822 *to* 1831.)—The *three republics*, now constituting Colombia:

1. United States of Colombia (formerly the confederation of New Grenada, until 1863; before that, the Republic of New Grenada, until 1858).
2. Equador.
3. Venezuela.

UNITED STATES OF COLOMBIA.—(*Bogota; Santa Fé de Bogota.*)—In conformity with the law of 8th June, 1853, the French metric system has been in force since 1st January, 1854 (including for shipping). For coin-

age the weight has been the French gramme since 1848. This law introducing the metric system is still permissive for *private* persons and is used at pleasure in their extensive business transactions. Consequently, in large transactions the old standards are also used.

ECUADOR, REPUBLIC OF.—(*Quito, or Francisco de Quito.*)—According to the laws of 5th December, 1856, the metric system has been that of the republic since 15th October, 1866 (ten years). Since the last mentioned date the metric system alone appears in *official* transactions.

A later law, that of 14th April, 1857, again orders the use of the metric system generally in all business transactions throughout the republic.

According to the law of 1856, once in every two years, on the 15th October, the weights and measures of each of the provinces, districts, and communes of the republic must be verified.

GUATEMALA.—(*Central American States; Guatemala, San Salvador, Honduras, Nicaragua and Costa Rica.*)—In Guatemala and Costa Rica, since 1858, the French metric system is legally in force, and in San Salvador the French weight, at least for coin purposes, which also, in Honduras, since 1869, is employed as the coinage weight; but in fact in Guatemala and Costa Rica the old Spanish-Castilian system is in use and controls, as well as in the other Central American States.

MARTINIQUE.—(*A French Antilles Island in the West Indies.*)—French weights and measures (metric) legal, yet other systems are much in use, the old Parisian and the English.

MEXICO.—The weights and measures of the States of the republic are legally the French metric. A decree of President Commonfort of the 15th March, 1857, ordered their introduction; requiring that *six months* after the date of the proclamation they be exclusively used in all governmental transactions (which was not done), and from 1st January, 1862, should be obligatory for all the inhabitants.

The law of the 15th March, 1861, ordered anew the exclusive use, for all purposes, of the French system of measures, from 1st January, 1862, but this law appearing to remain almost without effect for private working, an imperial decree was issued in November, 1865, again declaring the use of this system alone valid (or in force) throughout all the States.

The use of the new system appears to be extending to more and more places, but least in the wholesale trade (1873), the old weights and ell-measures being still employed.

The new measures retain the names of the corresponding old with the prefix "new."

PERU, REPUBLIC OF.—(*Lima.*)—The weights and measures of Peru are legally the French metric.

The introduction of the metric system has for many years been ordered, but as yet almost wholly without effect.

Later, in the year 1869, its adoption was again ordered, and for customs purposes it is in use. In general, the earlier or old Spanish-Castilian system, with some exceptions and peculiarities is used. For coin weight, the French gram (metric) is used.

UNITED STATES OF AMERICA.—The French metric system of weights and measures rendered permissive by law of 28th July, 1866. To the 5-cent copper nickel piece was given the metric weight of 5 grams (77.16 grains), by law of 16th May, 1866. To the silver coins of the United States of smaller denominations than one dollar, was given metric weights, by the law of 12th February, 1873. For postal purposes one-half ounce equals 15 grams and so on in progression.

URUGUAY, REPUBLIC OF.—(*Montevideo.*) ("*Oriental Republic of Uru-*

guay.")—French metric system of weights and measures legalized by decree of 20th March, 1862. This system is in use for customs purposes, but for other purposes does not appear to have been brought into common use. It is employed to some extent for coinage.

VENEZUELA, REPUBLIC OF.—(*Caracas.*)—In the year 1872, through an executive order of 18th July of that year, the French metric system was introduced, in conformity with which already, since the beginning of the year 1873, entries for customs settlements are required to be made.

Coin weight is the French gram (metric), in conformity with the coin law of 30th May, 1848. The weights and measures have been *legally* for many years (about ten years prior to 1874) the French metric, but in practice the metric system had found no place, and even the customs tariff of 12th May, 1867, took the earlier system of weights and measures as its basis. According to a governmental decree of 17th September, 1869, the metric decimal system was to be brought into use in all the customs transactions of the republic, and likewise by the consuls of the State in certifying goods and manifests.

EUROPE.

AUSTRIA.—In conformity with the law of 23d July, 1871, the French metric system of weights and measures was made obligatory from the 1st of January, 1876. The interval from the date of the authorizing law to the date from which it was made obligatory was about four and a half years.

BELGIUM.—(*Antwerp.*)—The metric system of weights and measures was introduced with old denominations during the union of Belgium with the Netherlands; that is, by the law of 21st August, 1816, and the royal decrees of 29th March and 30th November, 1817. By a Belgian law of 18th June, 1836, these names were withdrawn and French names introduced. A law of 1st October, 1855, created from 1st January, 1856, the exclusive use of the French system (including also the French medicinal weight).

DENMARK.—The unit of commercial weight since the law of May 1, 1863, is the pfund of 500 grams or the one-half kilogram. The unit of coin weight, in conformity with the Scandinavian coin convention of 18th December, 1872, and the law of 23d May, 1873, has been since 31st May, 1874, the metric gram; the convention to be in force until the end of December, 1884, ten years. The introduction of the complete metric system of weights and measures *is in prospect.*

On the 3d of October, 1876, the minister of interior recommended to the Parliament a project of a law accerding to which the use of the metric system of weights and measures was to be permissible for three years, after which its use should be compulsory throughout the kingdom. The coin weight under the coin law of 4th June, 1873, is the French metric, the kilogram.

FRANCE—The system of weights and measures known by common consentas the "metric system" was proposed by the Prince Talleyrand, then Bishop of Autun, in the year 1790. This system was declared the only system of weights and measures in France and in the French colonial possessions by the law of 1st of August, 1793.

The organizing law for the new measures and coins of the metric system was adopted on the 7th of April, 1795.

Under the organizing law of 7th April, 1795, and supplemental law of 15th August, 1795, money is reckoned since 1st July, 1796, and definitely since the coin law of March 28, 1803, in francs of one hundred centimes.

The metric system of weights and measures was definitely introduced

through the law of 10th December, 1799. The organizing law, as before mentioned, bearing date 7th April, 1795.

For small or retail trade the "systeme usuel" was introduced and permitted through decree of February 12, 1812, and the order of the minister of the interior, of 28th March in the same year, and was allowed to continue in use until by the law of 4th July, 1837, its use was forbidden from 1st January, 1840. Although forbidden from this date, the "systeme usuel" was actually much in use as late as 1861.

The interval from the antecedent organizing (constitutive) law of 7th April, 1795, and the law definitively introducing the metric system of weights and measures into France of 10th December, 1799, is four years and eight months.

The interval from the decree of 12th February, and the ministerial order of 28th March, 1812, permitting the temporary use of the so-called "systeme usuel," and 1st January, 1840, the date from which its use was forbidden, is nearly twenty-eight years. (Twenty-seven and three-fourths years).

The interval from the date of the law of 4th July, 1837 (interdicting or forbidding the use of the "systeme usuel" after the close of the year 1839), to 1st January, 1840, the date from which the use of the complete or pure metric system was made compulsory, was two and a half years.

GERMANY.—The customs pound (500 grams), the standard customs weight of the Customs Union, became the national weight on 1st July, 1858, throughout the greater part of Germany, and for a shorter time throughout the present empire.

It was also made the postal weight of the German Postal Union, and the railroad weight (for freight) of the Customs Union, and since February, 1852, the customs weight of the Austrian Empire, and through the Vienna coin treaty of 24th January, 1857, the coin weight in nearly all the German States, and also in Austria.

A decree relative to weights and measures for the North German Union was promulgated 17th August, 1868. This decree made the use of the metric system of weights and measures permissive from 1st January, 1870, and compulsory from 1st January, 1872. By a subsequent law of the German Empire, the same was re-enacted and extended throughout the realm. Bavaria adopted it by a law of 29th April, 1869.

The interval from the date of the decree for the North German Union to the date when the use of the system became obligatory was three and one-third years; and from the date of the law of Bavaria to its compulsory use was two and two-third years.

In Rhenish Bavaria the metric weights and measures were introduced in the year 1840. Outside of the Rhenish provinces the system was non-metric until the metric system was declared optional from 1st January, 1870, and obligatory from 1st January, 1872.

In Baden, the weights and measures made commensurable with the metric system by law of November, 1810, came gradually into use, until by order of 21st August, 1828, their use was made compulsory with the year 1831, except as regards medicinal weights, which have been metric from July 1, 1864.

In the Grand Duchy of Oldenburg, until the end of 1871, the system of weights and measures in different places differed. Only the metric *weight* by the law of 19th June, 1857, was made common from and after 1st July, 1858; an interval of *one* year. In Lubeck this weight was introduced later.

For *customs purposes*, the new *pound* (½ kilogram) and the centner

(50 kilograms) have been used in all the States of the German Zollverein (Customs Union) since 1st January, 1854, divided, however, as to the pound into thirty loth. From the same date the pound (½ kilogram), divided into thirty loth, was adopted by the German-Austrian Zollverein for *postal purposes*.

By a union of several of the German States the metric pound and centner were adopted in 1856. Since 24th January, 1857, the *coin pound* of 500 grammes has been employed for the purposes of *coinage*. *Metric medicinal weight* has been used since 1858.

GREAT BRITAIN.—The French metric system of weights and measures is permissive by law of 1864.

GREECE.—(*Athens.*)—French metric system of weights and measures introduced by law of 28th September, 1836, but with the common Grecian names. In the Ionian Islands, however, the English weights and measures have been legalized since 1829.

HUNGARY.—The use of the new Austrian (metric) system of weights and measures was made permissive from 1st January, 1873, and obligatory from and after 1st January, 1876, an interval of three years. Article VIII, of the law of 1874, provided for the introduction of the new metric system to be in force January 1, 1876.

ITALY.—Since the establishment of the Kingdom of Italy (17th March, 1861), the weights and measures are the French metric. This system has been compulsory over the *Italian* peninsula and Sicily since 1st January, 1863. It was introduced into Venetia (Venice) by the law of 11th March, 1869. It was introduced into Lombardy and Venice, when under the French dominion, in the year 1803, but came into permanent use only for governmental or administrative purposes. On the *island of Sardinia* it has been in legal use since 1st January, 1846; in Genoa since 1st March, 1847; in the rest of *Piedmont* since 1st April, 1850; in the *continental part* of the *former Kingdom of Naples* since 1st January, 1861. In the earlier *Papal States* its introduction was ordered in 1848 to take effect from the year 1850, but prior to the end of 1870 has not been much employed.

In the former Duchy of *Parma*, since 1854, the Austrian (or German) customs-weight (the pound of 500 grammes) has been employed for custom purposes. In *Leghorn* the metric weight for wholesale purposes has been still longer in use. In the former Duchy of *Modena* the metric system of weights and measures was introduced first in 1808, and re-established in 1849.

NETHERLANDS.—The French metric system of weights and measures was introduced by the law of 21st August, 1816, and the royal decrees of 29th March and 30th November, 1817. The length measure to be in force since 1821; square and field measure since 1821; fluid measure since 1830; commercial, medicinal, and apothecaries' weight since 1821.

The metric system established by the law of 1816 and decrees of 1817 applied the old designations to the metric units. The law of 7th April, 1869, established from the commencement of the year 1870 a new series of international names, with the optional use for the first *ten* years of the old denominations.

NORWAY.—In the Norwegian Parliament, on the 22d of April, 1875, the government moved for the introduction of the metric system of weights and measures.

PORTUGAL.—The French metric system of weights and measures compulsory since 1st October, 1868. Metric measures of length and surface have been legally in use in Lisbon since 1st January, 1860; in the provinces since 1st March, 1860; for capacity and weight throughout the

whole land since the end of 1862. For customs, tonnage-dues, warehousing, and the assessment of taxes, the French system has been in force in Lisbon and Oporto since September, 1860; so also for the measurement of shipping by a decree of 25th August, 1860.

ROUMANIA.—(*Bucharest.*)—According to a royal edict of 27th November, 1874, the government is charged with the duty of introducing the new or French metric system of weights and measures, but its use is not yet accomplished. For railroad purposes they reckon according to the French kilometre.

SWEDEN.—The French system of weights and measures will be obligatory with the year 1883, permissive during the years 1881 and 1882; and for customs and postal purposes, also for railroad transportation, obligatory from the commencement of 1881.

The coin weight is in conformity with the Scandinavian coin convention of 18th December, 1872—the French metric. The medicinal and apothecary weight is the French metric gramme weight, in conformity with the law of 1864.

SPAIN.—(*Madrid.*)—French metric weights and measures, introduced by a law of 19th July, 1849, to go into operation in November, 1852. For a portion of the provinces the new system was in force on the 1st January, 1855, and in all Spain from 1st January, 1859.

SWITZERLAND.—By agreement or convention of 17th August, 1835, known as the "Maass concordats," entered into between twelve Swiss cantons, other cantons joining later, a modified form of the metric system was established, to go into operation generally with 1st January, 1840, an interval of four and a half years, but in Lucerne in the year 1838, an interval of two and a half years.

The federal law of 23d December, 1851, introduced for the whole of Switzerland the system of the "Maass concordats" of 17th August, 1835, to be in force in all the cantons at the latest by December 31, 1856, an interval of five years. The facts are that almost everywhere it has been enforced since 1st January, 1853, an interval of one year; in Neufchatel, however, since March 1, 1858, an interval of six years. In June, 1868, the federal council by law made the use of the *pure* metric system *optional* side by side with the present system of the "Maass concordats."

ASIA.

BRITISH EAST INDIA.—(*Calcutta.*)—In the year 1859 the British East India Government recommended the introduction of the French metric system of weights and measures, but as yet without result.

An act to provide for the ultimate adoption of a uniform system of weights and measures of capacity throughout British India was passed by the governor-general of India in council in 1871. The act orders:

ART. 2.—The primary standard of weight shall be called a *ser*, "a weight of metal equal when weighed in a vacuum to the weight known in France as the *kilogramme*."

ART. 3.—The units of weights and measures of capacity shall be, for weights, the said *ser;* for measures of capacity, a measure containing one such *ser* of water at its maximum density, weighed in a vacuum.

ART. 4. * * * Every *weight* or *measure* of capacity other than said units "shall be an integral multiple or integral submultiple of one of the units aforesaid."

Unless otherwise ordered "the subdivisions of all such weights and measures of capacity shall be expressed in decimal parts."

The use of metric weights and measures is permissive, and the local governments are empowered to make it compulsory at discretion.

TURKEY.—(*Constantinople.*)—The French metric system of weights and measures introduced by the organizing law of September, 1869, to go

into effect for all purposes in the administration of the empire from March, 1871. Its use optional to the public from March, 1871, to March, 1874, from which date its use was to be obligatory.

The interval from the date of the organizing law to the use of the system for purposes of the government is one and a half years, and the interval from the date when made permissive to that when made generally obligatory is four and a half years.

JAPAN.—Weights and measures in general are non-metric, but for coinage, in part, the metric unit of weight is employed. "The gold yen, the unit of account, contains of fine gold one grain and a half and weighs one grain and two-thirds, being of nine-tenths fineness," consequently the decagram of gold of the ordinary standard of nine-tenths fineness is equivalent in value exactly to six yens. It is stated to be the intention of the government to introduce into Japan at an early period a new system of weights and measures based on the decimal system of France.

AFRICA.

EGYPT.—In July, 1875, the introduction of the metric system of weights and measures was ordered. For coinage, the gramme-weight has already for some time been in use. For a measurement of shipping, the Turkish, the metric ton of 1,000 kilogrammes, is used.

FRENCH COLONIES.

ALGIERS.—Since March 1, 1843, the metric system of weights and measures is legalized. The use of the older system is strongly forbidden, but it continues to a great extent in use.

REUNION, ISLE OF (*formerly Isle of Bourbon, and from* 1809 *to* 1814 *Isle of Bonaparte*), *Africa*.—Weights and measures, the old Parisian, but more and more the new metric coming into use. The metric weight, the half kilogramme, has for many years been in general use.

SENGEAMBIA (*Africa*).—In the French Senegal colony, by a decree of 15th June, 1826, the use of the old weights and measures is forbidden, with the exception of capacity measures for fruit, and the French metric system introduced.

To us, then, the metric system is no longer an experiment. Already its use is obligatory in Belgium, France, Germany, Greece, Netherlands, Italy, Portugal, Roumania, Spain, and Switzerland; in the Argentine Republic, Brazil, Peru, San Domingo, United States of Colombia, and Uruguay—countries aggregating a population of 181,000,000—while its use is partial or legalized in Austria, Azores, Madeira and Cape de Verde Islands, Central American States, Denmark, Japan, Sweden, Norway, Turkey, Spanish Possessions, Great Britain and the British Possessions, and our own country, aggregating a population of 375,000,000 more.

In view of these facts the obligatory use of the metric system in this country seems feasible, and, in my opinion, it is desirable. Not only will such use bring about a complete uniformity of standards throughout the country, but the system will prove especially valuable for international purposes.

From table E, herewith appended, it will be seen that for the year ending June 30, 1877, the value of our imports from countries where the metric system is obligatory amounted to \$177,807,469; partially in use, \$17,378,735; legalized, \$265,211,585; not legalized or in use, only \$23,804,140. Of the amount received from countries where its use is legalized, Great Britain and British Possessions furnish \$185,667,400.

With these countries our present system is partly in harmony, but unfortunately the bulk of our trade with them, as before stated, is made up of articles measured by the bushel and gallon, neither of which standards correspond to any bushel or gallon of this country. It should be borne in mind that the only legalized system of weights and measures in this country to-day is the metric system, and that this system is the only one we possess in harmony with that of any other country.

Of the time necessary for the government and the people to prepare for its obligatory use there may be some diversity of opinion. Considering the experiences of other nations and the admitted aptness of our people for adapting and utilizing improved methods of business, I am clearly of opinion that a notice of two years will be sufficient to enable the government to prepare for the adoption of the system in all administrative transactions, and that a notice of ten or fifteen years will be sufficient to enable the country to prepare for its obligatory use in transactions between individuals. Possibly, for a while thereafter, a compromise with vulgar fractions and existing terms may be necessary, but meanwhile the new system will be taught in our schools, explained in the public press, and exemplified by our experience, and in a comparatively brief time the use and terms of the old system will disappear as have those of English money before the advance of our decimal coinage.

Very respectfully,

J. K. UPTON,
Chief Clerk.

Hon. JOHN SHERMAN,
Secretary of the Treasury.

A.—*Table of the usual measures of length exhibiting the number of inches in each denomination and their equivalents in terms of the metric system.*

One meter = 39.370432 inches; one inch = 0.025399772 meter; one inch, approximately 0.0254 meter.

1 point	=	$\frac{1}{72}$	inch	=	0.000353—	meter.
1 line	=	$\frac{1}{12}$	inch	=	0.002117—	meter.
1 barleycorn	=	$\frac{1}{3}$	inch	=	0.008467—	meter.
1 nail	=	$2\frac{1}{4}$	inches	=	0.057149+	meter.
1 palm	=	3	inches	=	0.076199+	meter.
1 hand	=	4	inches	=	0.101599+	meter.
1 link	=	7.92	inches	=	0.201166+	meter.
1 span	=	9	inches	=	0.228598—	meter.
1 quarter	=	9	inches	=	0.228598—	meter.
1 foot	=	12	inches	=	0.304797+	meter.
1 cubit	=	18	inches	=	0.457196—	meter.
1 ell (Flemish)	=	27	inches	=	0.685794—	meter.
1 yard	=	36	inches	=	0.914392—	meter.
1 ell (English)	=	45	inches	=	1.142990—	meters.
1 ell (French)	=	54	inches	=	1.371588—	meters.
1 fathom	=	72	inches	=	1.828784—	meters.
1 rod, perch, or pole	=	198	inches	=	5.029155—	meters.
1 double rod or half chain	=	396	inches	=	10.058310—	meters.
1 chain	=	792	inches	=	20.116619+	meters.
1 tally	=	3,960	inches	=	100.583097+	meters.
1 furlong	=	7,920	inches	=	201.166194+	meters.
1 cable length	=	8,640	inches	=	219.454033+	meters.
1 mile	=	63,360	inches	=	1,609.329554—	meters.
1 league	=	190,080	inches	=	4,827.988662—	meters.

B.—*Table of the usual measures of weight, exhibiting the number of grains in each denomination and their equivalents in terms of the metric system.*

One gram = 15.43234874 grains; one grain = 0.06479895036 grams; one grain, approximately 0.0648 grammes.

1 troy grain	=	1	grain	=	0.064799	gram.
1 apothecary grain	=	1	grain	=	0.064799	gram.
1 avoirdupois grain	=	1	grain	=	0.064799	gram.
1 scruple	=	20	grains	=	1.295979+	grams.
1 pennyweight	=	24	grains	=	1.555175—	grams.
1 dram (avoirdupois)	=	27.344—	grains	=	1.771846+	grams.
1 dram (apothecary)	=	60	grains	=	3.887937+	grams.
1 ounce (avoirdupois)	=	437.5	grains	=	28.349541—	grams.
1 ounce (apothecary)	=	480	grains	=	31.103496+	grams.
1 ounce (troy)	=	480	grains	=	31.103496+	grams.
1 pound (troy)	=	5,760	grains	=	373.241954+	grams.
1 pound (apothecary)	=	5,760	grains	=	373.241954+	grams.
1 pound (avoirdupois)	=	7,000	grains	=	453.592653—	grams.
1 quarter (25 lbs. av.)	=	175,000	grains	=	11,399.816313+	grams.
1 quarter (28 lbs. av.)	=	196,000	grains	=	12,700.594271—	grams.
1 hundred-weight (cental)	=	700,000	grains	=	45,359.265252+	grams.
1 hundred-weight (112 lbs. av.)	=	784,000	grains	=	50,802.377082+	grams.
1 ton (2,000 lbs. av.)	=	14,000,000	grains	=	907,185.30504 +	grams.
1 ton (2,240 lbs. av.)	=	15,680,000	grains	=	1,016,065.541645—	grams.

C.—*Table of the usual measures of capacity, exhibiting the number of cubic inches in each denomination and their equivalents in terms of the metric system.*

[One liter or cubic decimeter = 61.02538677 cubic inches; one cubic inch = 0.0163866227 cubic decimeters.]

	Cubic inches.	Liters or cubic decimeters.
1 minim	0.0038—	.0000616—
1 fluid-drachm	0.226—	.0036966—
1 fluid-ounce	1.805—	.029573—
1 gill (wine measure)	7.219—	.118291—
1 pint (wine measure)	28.875	.473164—
1 pint (dry measure)	33.6	.550596—
1 pint (beer measure)	35.25	.577628+
1 quart (wine measure)	57.75	.946327+
1 quart (dry measure)	67.2+	1.101191+
1 quart (beer measure)	70.5+	1.155257—
1 gallon (wine measure)	231	3.785310—
1 gallon (dry measure)	268.8+	4.404765+
1 gallon (beer measure)	282	4.621028—
1 peck (dry measure)	537.6+	8.809530+
1 bushel (dry measure)	2,150.42	35.238121+
1 firkin (beer measure)	2,538	41.589248+
1 barrel (wine measure)	7,276.5	119.237269+
1 tierce (wine measure)	9,702	158.983013+
1 barrel (beer measure)	10,152	166.356994—
1 hogshead (wine measure)	14,553	238.474590+
1 hogshead (beer measure)	15,228	249.535490+
1 puncheon (wine measure)	19,404	317.966027—
1 puncheon (beer measure)	20,304	332.714987+
1 pipe (wine measure)	29,106	476.949040+
1 butt (beer measure)	30,456	499.070981—
1 tun (wine measure)	58,212	953.898081—
1 chaldron (dry measure)	77,415.12	1,968.572363—

D.—*Table showing the weight in pounds avoirdupois of a bushel of different grains and other commodities as established by law in the States and Territories of the United States.*

States and Territories.	Rye.	Wheat.	Indian corn.	Buckwheat.	Barley.	Oats.	Bran.	Onions.	Irish potatoes.	Sweet-potatoes.	Beans.	Timothy-seed.	Hemp-seed.	Blue-grass seed.	Millet-seed.	Hungarian grass seed.	Flaxseed.	Clover-seed.	Redtop-seed.	Osage-orange seed.	Broom-corn seed.	Cotton-seed.
Maine		60	56	48	48	30		52	60		64											
New Hampshire	56	60	56			30			60		60											
Vermont	56	60	56	46	48	30		54	60		60	42						60				
Massachusetts	56	60	56	48	48	32		52	60													
Rhode Island	56		56		48	32		50	60													
Connecticut	56	60	56	48	48	32		50	60		60											
New York	56	60	58	48	48	32			60		62	44					56	60				
New Jersey	56	60	56	50	48	30		57	60	54	60						55	64				
Pennsylvania	56	60	56	48	47	30												62				
Delaware		60	56																			
West Virginia	56	60	56	52	48	32			60		60	45					56	60				
Louisiana	32	60	56		32	32																
Ohio	56	60	56	50	48	33			60	50	60	45	44		50	50	56	62				
Indiana	56	60	56	50	48	32		48	60		60	45	44	14			56	60				
Kentucky	56	60	56	52	48	33½	20	57	56		60	45	44	14			56	60				
Illinois	56	60	56	52	48	32	20	57	60	55	60	45	44	14			56	60				
Michigan	56	60	56	48	48	32		54	60	56	60	45	44	14	50	50	56	60	14	33		
Wisconsin	56	60	56	42	48	32			60			46					56	60				
Minnesota	56	60	56	42	48	32			60									60				
Iowa	56	60	56	52	48	33	20	57	60	46	60	45	44	14	45	45	56	60		32	30	
Nebraska	56	60	56	52	48	34	20	57	60	50	60	45	44	14	40	60	56	60		32		
Missouri	56	60	56	52	48	32	20	57	60		60	45	44	14			56	60				33
Kansas	56	60	56	50	50	32	20	57	60	55	60	45	44	14	55	55	56	60				
Colorado	56	60	56	52	48	33½		57	60		60	45	44	14				60				
California	54	60	52	40	50	32							44	14								
Oregon	56	60	56	42	46	36			60									60				
Arizona	56	60	54		45	32					60											
Dakota	56	60	56	42	48	32			60		60	42						60				
Montana	56	60	56	52	48	35		57	60		60	45	44	14				60				
Washington	56	60	56	42	45	35		50	60		60	40						60				

States and Territories.	Corn-meal.	Rye-meal.	Salt.	Apples.	Peaches.	Quinces.	Pears.	Berries.	Dried apples.	Dried peaches.	Dried plums.	Mineral coal.	Stone-coal.	Corn on cob.	Hair.	Rutabaga.	Sugar-beets.	Mangel-wurzel.	Parsnips.	Carrots.	Coke.	Hominy.	Malt.	Castor-beans.	Pease.	White turnips.	Lime.	Charcoal.	Sorghum-seed.
Maine	50	50													11	60	60	60		50					60				
New Hampshire	50	50																							60				
Vermont																									60				
Massachusetts	50	50	70																										
Rhode Island	50	50																											
Connecticut	50	50														60	60	60	45	55					60	50			
New York																									60				
New Jersey									25	33															60				
Pennsylvania			A. 85; B. 70; C. 62									76									40								
Delaware	D. 44; E. 48																												
West Virginia									25	33		80																	
Louisiana																													
Ohio									25	33		F. 80; G. 70		70								60	34		60				
Indiana	50		50						25	33		H. 80; I. 70		68										46					
Kentucky	50		50										F. 80; G. 70																
Illinois	48		50; C. 55						24	33			80	70	8	55							38	46			80		
Michigan	50		56					40	22	25	28	80		70		48								46	60		70		
Wisconsin									28	28																			
Minnesota									28	28																			
Iowa			50	48	48	48		32	24	33			80	70										46			80		
Nebraska	50		50						24	33			80	70	8	55							30	46	60		80		30
Missouri			50						24	33		80									26			46				26	
Kansas	50		50						24	33			80	70	8	55							32	46			80		
Colorado	50		50																										
California																													
Oregon				45	54				28	28																			
Arizona																													
Dakota														72											60				
Montana	50		50														50		50	50						50			
Washington				45			45		28	28						50	50	50							60	50			

A.—Coarse. B.—Ground. C.—Fine. D.—Sifted. E.—Unsifted. F.—Bituminous. G.—Cannel. H.—Mixed in the State. I.—Mixed out of the State.

NOTE.—No laws specifying the weight to the bushel of grain or other commodities appear to have been passed by the States of Maryland, Virginia, North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Tennessee, Arkansas, Texas, or Nevada, nor by the Territories of Idaho, New Mexico, Utah, or Wyoming.

E.

Statement showing the population, imports into and exports from the United States, of the various countries of the world, arranged in groups according to the adoption and legalization of the metric system.

Countries.	Population.	Imports, year ended June 30, 1877.	Domestic exports, year ended June 30, 1877.	Foreign exports, year ended June 30, 1877.
OBLIGATORY.				
Argentine Republic	1,812,490	$3,449,559	$1,129,168	$97,614
Belgium	5,336,634	5,079,149	18,206,025	626,034
Brazil	10,108,291	43,498,041	7,499,118	83,695
Chili	2,068,424	698,716	2,175,467	52,084
France and French possessions	42,100,921	52,862,387	48,526,163	1,591,782
Germany	42,723,242	33,035,485	58,192,511	655,303
Greece	1,457,894	523,128	190,170	6,458
Italy	27,482,174	7,105,366	8,484,496	10,172
Mexico	9,276,079	15,444,583	4,509,041	1,389,692
Netherlands	3,809,527	2,547,119	19,411,757	156,578
Peru	2,720,735	1,545,461	1,239,006	61,546
Portugal	4,298,881	524,826	2,361,734	19,030
Roumania	5,073,000	....	....	....
San Domingo	250,000	560,709	662,261	42,920
Spain	16,551,647	3,280,836	10,461,750	11,726
Switzerland	2,669,147	....	....	....
United States of Colombia	2,910,329	5,454,393	4,022,232	92,167
Uruguay	350,000	2,197,711	1,077,434	22,953
Total	180,999,415	177,807,469	179,148,333	4,919,754
PARTIALLY IN USE.				
Austria	37,700,000	414,020	2,666,246	2,300
Azores, Madeira, and Cape de Verde Islands	378,681	92,351	413,637	1,638
Central American States	2,577,454	2,883,602	1,304,348	52,338
Denmark	1,903,000	9,053	3,329,725	....
Japan	33,110,825	13,689,433	2,539,641	385,243
Sweden and Norway	6,186,173	243,562	3,041,625	15,144
Turkey in Europe	8,500,000	46,714	8,344,522	....
Total	90,356,133	17,378,735	21,639,744	456,663
LEGALIZED.				
Great Britain and British possessions	237,392,000	185,667,400	437,802,600	14,163,923
Spanish possessions (Cuba, Porto Rico, &c.)	8,381,000	79,544,185	15,253,358	4,033,651
Total	245,773,000	265,211,585	453,055,958	18,197,574
NOT LEGALIZED OR IN USE.				
Danish West Indies	37,600	284,480	743,164	8,592
Dutch East Indies	24,481,000	4,511,444	2,667,893	....
Dutch West Indies and Dutch Guiana		735,525	987,322	18,308
China	433,500,000	11,141,447	3,178,594	2,173,290
Greenland	9,800	137,465	....	....
Hawaiian Islands	56,897	2,631,763	1,296,942	163,520
Hayti	572,000	3,303,709	3,851,336	64,664
Liberia *	18,000	57,470	122,819	1,861
Russia	84,702,960	612,534	4,423,661	769
Turkey in Asia and Africa	33,336,000	382,303	993,979	....
Total	576,714,277	23,804,140	18,265,710	2,431,004

* Population of Liberia: Negroes, civilized, 18,000; negroes, indigenous, 700,000.

Population of United States in 1870, 38,558,371.

System lately legalized, see above.

Reply of C. P. Patterson, superintendent of United States Coast Survey.

UNITED STATES COAST-SURVEY OFFICE,
Washington, March 23, 1878.

SIR: I have the honor to acknowledge the receipt of your communication of the 10th of November, 1877, with which was transmitted a copy of the resolution adopted by the House of Representatives in relation to a proposed change from the standard units of weight and measure, now in common use in the United States, to those of the metric system, and requesting an expression of views from this office.

Frequent consultation with Prof. J. E. Hilgard, the assistant in charge of the Coast-Survey Office and inspector of standard weights and measures, has shown that our views generally coincided in relation to the metric system itself, and also in regard to the general policy to be followed in the endeavor to substitute throughout the country a system of weights and measures entirely foreign to that in common use with us, and which has grown through many generations to be part of our inherited thought. Professor Hilgard having, moreover, had special charge and direction for many years of the details pertaining to our standard weights and measures, I placed the matter of inquiry, which was the subject of the House resolution, in his hands for discussion. The result is the very able report, which I have the honor to inclose herewith, and which I fully indorse, except in regard to the time requisite for effecting the change and making it obligatory in law.

As Professor Hilgard well says, "Our habit is to have our laws follow our customs, and not our customs our laws," the first being from the people and the last from the arbitrary action of irresponsible authority.

To effect the change referred to without shock to the people and great loss to very large investments, it would be necessary, in my opinion, for the law to require that all governmental and State business and returns should be expressed in the terms of both systems—the system now in use and that proposed to be introduced, side by side; that the metric system should be taught in all institutions of learning, both public and private; and that there should be constant agitation and energetic pressure of the new system upon public attention by all persons earnestly interested in the change for a period of not less than thirty-five years.

It is certain that very few adults now living would ever become familiar with the units of the metric system, but would retain the habit of reverting to the *foot*, the *pound*, and our other units, mentally at least, even after the law had disfranchised the old units.

The problem of a change of the kind proposed in a great commercial, agricultural, and manufacturing country like our own, is vastly more difficult than it would be in nations the larger portion of the inhabitants of which deal only in a limited manner with small quantities. This subject has been a matter of much thought to myself for several years, and the more I have heard it discussed the more convinced I have become that a matter so grafted into the daily habit and thought of the whole people can only be changed by, as it were, the slowest absorption, and that not less than thirty-five years will be required to effect even a semblance of a change, after the date of the law fixing a time when the new system shall be compulsory.

Some enthusiasts earnestly believe, taking counsel of their own earnestness and hopefulness, that a complete change could be effected throughout the country in, say, from five to ten years, but we have only to remember the length of time it has required for the decimal coinage,

the most facile of all standards to change, to obtain universal acceptance and usage in all parts of the United States. In some places, to this day, after a hundred years of trial, we occasionally hear that eight shillings, or six shillings, or four and sixpence "make a dollar"; and only a few years since we heard of "picayunes" and "bits," which respectively were worth 6¼ cents and 12½ cents, suggesting the naturalness to the uninstructed mind (a majority in all countries) of the binary system in lieu of the decimals, as the system of *halving* is almost universal. The decimal is, for all scientific computations, indispensable, but it is still an open question, which is the best for ordinary use in life, the decimal or the binary—this *natural* or that artificial system.

I am well aware that the rising generation in this rapid nation of ours, who look forward, think a view of thirty or forty years interminable; but we, who look back, know how sadly short it is. The only hope of a thorough change from our system to the metric system is in the education of, not only the present rising generation, but of that which is to come after a law shall be adopted fixing the date when the new system should be compulsory.

I earnestly recommend that in a matter so nearly touching all relations of life in this busy nation, no law be passed upon this subject without the most mature deliberation, and that when passed, it should not have compulsory effect until at least thirty-five years after the date of its passage.

Very respectfully, yours,

C. P. PATTERSON,
Superintendent Coast Survey.

Hon. JOHN SHERMAN,
Secretary of the Treasury, Washington, D. C.

BUREAU OF WEIGHTS AND MEASURES,
UNITED STATES COAST-SURVEY OFFICE,
Washington, March 21, 1878.

SIR: The answer to the resolution of the House of Representatives, relative to the obligatory use of metric measures, referred by you to this office for report, may be conveniently arranged under the following heads:

I. As to the operations of the Coast Survey.
II. As to those of other bureaus of the Treasury Department.
III. As to the people at large.

These will be considered consecutively, and as the last question of the resolution opens the whole subject it will not be improper to consider its bearing upon some other branches of the public service.

I. In the operations of the Coast Survey the meter is used, and has been employed from the first as the unit of measure. The depths of water or soundings are, nevertheless, expressed in feet and fathoms, in conformity with the immemorial custom of American and British mariners. To have given the depths of channels in the unfamiliar unit of meters, would have obviously destroyed the usefulness of the charts and added another element of danger. The object of the charts being that of giving important information in the most available form, not that of diffusing a knowledge of the metric system, the use of feet and fathoms was imperative for the depth of water, and as a matter of consistency the elevations of the land are likewise expressed in feet.

On the Coast-Survey maps, in addition to the natural or metric

scale, expressed in a decimal ratio to the natural dimensions, such as $\frac{1}{10000}$, $\frac{1}{20000}$, &c., are given scales of land miles and sea miles, the latter being an angular rather than a linear measure, viz, 1′ of arc.

In the printed tables of positions determined by the Coast Survey, the distances are given in meters, yards, and miles.

After these explanations, it will be apparent that the metric system is now used in the Coast Survey to the full extent that is consistent with the usefulness of the form in which the results are given to the people.

The exclusive use of metric units would deprive the charts of much of their usefulness, at least until the metric system had become perfectly familiar to our mariners, and they had accustomed themselves to think of the draught of vessels and to regulate sounding-lines in meters and tenths.

If American charts of American coasts were now issued with depths in meters, the result would be that every one would use the British reproduction of the same, in which the customary units are used.

The only mode of furthering the gradual adoption of the metric units in navigation would seem to be by the publication of the charts in two forms, one giving fathoms and feet, the other meters and tenths, in order that the mariner or pilot may choose those which he prefers.

II. Other bureaus of the Treasury Department in whose operations measures of weight, length, or capacity are seriously involved, are those having charge of *coinage*, *customs*, and of *internal revenue*.

The officers having charge of those important interests have, no doubt, been asked to express their opinions; but the form of reference of the House resolution to this office seems to call for an independent review of the question.

In the matter of coinage there appears to be no serious objection to making the exclusive use of metric weights obligatory. In the inside operations of the mints, they have long been employed in assaying. In the transfer of bullion and coin troy ounces, with decimal subdivisions, are in customary use. It cannot be said that metric units would be more convenient, since the advantages of a decimal system are already obtained; but they would be equally so, the persons engaged in the work being of great intelligence and readily able to make their statements in either form. Depositors of bullion for coinage or dealers with the mints, being beneficiaries, could be reasonably required to conform to any system the government saw fit to adopt.

In the matter of *customs* or *duties on imports*, the question assumes a peculiar form. Importations from nations using metric units are now stated in metrical invoices, while those from non-metric nations, of which the invoices from Great Britain form the larger part, are mainly stated in the customary units of this country, and in conformity with the terms of the tariff.

As the metric units are legal in this country, it would appear to require only an executive order that the duties be levied upon the metric invoices, according to the lawful equivalents, without first converting meters into yards, kilograms into pounds, liters into gallons. On the other hand, to require invoices in the customary units to be transformed into metric units, as would be implied by the "obligatory" use of the latter, appears to serve no useful purpose except that of propagating the metric system to the great inconvenience of everybody concerned. The permissive use of two different sets of units in assessing the duties may appear to some minds objectionable as a want of "system," but there is an inherent diversity in the case which has to be met at one point or the other, and which may be illustrated by saying that it is

doubtless convenient that some custom-house officers should know the German and French languages as well as the English. Until all nations use the same language and the same money, but little is gained in the way of unification of values by making the units of weight and dimension alike.

In view of the want of simple relations between the customary and the metric units, the department may find it convenient to procure some legislative authority for throwing off certain fractions in the table which would express the duties on metric invoices, on the basis of the legalized equivalent. If such concession to simplicity were made in favor of the metric units, their employment would doubtless be stimulated by such advantage.

Recurring to the question of the House, what inconvenience to the public service would arise from the obligatory use of the metric system in the customs department, the answer is that great inconvenience would arise from the want of familiarity with that system of the officers assessing the duties. It must be borne in mind that the efficiency of such an officer depends in the greatest degree upon his familiarity with the values of goods submitted to his inspection, and that he cannot separate in his mind the expression of measure from that of value. The expression which gives him a check on fraudulent invoices is fixed in his mind in such form as—this quality of silk is worth so much per yard; this tea is worth so much per pound, &c. The transformation into other terms of measure will break away entirely from his habits of thought, and his experience is practically lost.

It is not disputed that other and younger men would gain experience on the new basis, and the question as to the term within which the use of a new system might be made obligatory and exclusive may, from this point of view, be answered that not less than twelve years should elapse. We should always bear in mind, however, that if any term be fixed it will be necessary to hold out such contingent inducements as to lead the people to adopt that system in their private transactions; otherwise we should find ourselves, at the end of any stated term, confronted by the same state of facts as at present, namely, that the usage of the people does not conform to that proposed by the government.

Moreover, we should bear in mind that in this matter of duties on importations, as in that of taxes on domestic manufactures, the government is the beneficiary, unlike the case of *coinage* before treated of, and that in the latter cases the government practically assumes to be a partner in the transaction, and should not impose conditions onerous to its active partner, the importer, or home manufacturer.

In the *Internal-Revenue Department* the principal subjects of taxation are tobacco and alcoholic spirits. The value of the former product depends so much upon qualities which are not reducible to weight or measure that it need not be specially considered here, since general considerations applied to spirits will equally apply to tobacco.

A very large proportion of the internal revenue is derived from the imposts upon alcoholic spirits. The questions submitted bear most forcibly upon this branch of the public service, as it is a case where the practice of estimating the values is of no consequence to other nations, it being wholly a matter between the government and the people engaged in the business of converting grain into alcohol.

The government is largely the beneficiary in the transaction. It is not only due to the people that they should not be needlessly compelled to use an unfamiliar way of accounting with the government, but it is greatly to the interest of the latter that in a matter of so vast importance to its

revenue the experience of its officers should not be lost. An experienced gauger, to give an illustration, has a check on his measures and calculations by familiarity with sizes of casks, the contents, in *gallons*, of which he can estimate very nearly; but if required to express them in *liters*, this experience would wholly fail; and it is safe to say that such familiarity with the metric measures would never be acquired by the same persons.

The objection, then, to making the use of the metric measures obligatory in this part of the public service is that the liability to error would be greatly increased, and that the manufacturer and dealer would lose the advantage they now have, and which is fairly due them, of having the taxed value of the product expressed in quantities that are customarily used in their trade.

On the other hand, the advantages to be derived from the use of metric measures are, in this instance, hardly assignable.

The statistics of this and other branches of the public service would doubtless be more universally available if they were expressed in both the customary and the metric units. This can be readily effected by converting aggregates, without imposing the use of metric measures in every single transaction.

The general answer to the question of how long a preliminary notice should be given before the obligatory use can be introduced without detriment to the public service, necessarily depends largely upon the estimate of the time that must elapse before the people become practically acquainted with the new system. So far as the matter of the collection of taxes upon spirits is concerned, it is the opinion of this office that it should not be inforced before 1890, in order to give time for the instruction now given in public schools to reach a large number of officers and persons engaged in the business.

III. In attempting to form an opinion upon the question, "What objections there are, if any, to make the metrical system obligatory in all transactions between individuals, and what is the earliest date that can be set for its obligatory use throughout the United States?" the following considerations present themselves:

1. That the adoption of the metric system by the people of the United States would be an advantage is taken for granted by the House resolution. Admitting this assumption, it is useful to state here the grounds upon which it rests. These are twofold, namely, inherent convenience and probable universality. The first point is sustained by its conformity to the universal system of decimal arithmetic, and the direct relations between measures of length, volume, and weight. The second is asserted on the basis that the metric system has been adopted by nations whose population far outnumbers that of those nations with whom the Anglo-Saxon units are customary.

A careful review of the logical and historical facts in the premises leads this office to the opinion that if any universal system of weights and measures is to obtain, the metric system is the one that has at present the greatest probability of supplanting all others. Before its adoption by the German and Austrian empires, within the last six years, this probability was by no means very decided; for many of the millions of people counted as having the metric system in use, were in fact not using any measures at all, being herders and peasants, while among the non-metric nations manufactures and commerce were flourishing. The United States, Great Britain, and Russia having identically the same units of length and weight, while those of Germany and Austria were nearly the same and called by the same names, it appeared not at

all improbable that in unifying their local diversities the latter states would also adopt the Anglo-Saxon units. Since they have, however, adopted the metric units and made their use compulsory, we may consider the changes turned in favor of the latter, and may assume that if the Government of the United States would promote general uniformity, it must do so by furthering its actual adoption by the people in their private transactions.

The legalization of the use of metric units, in 1866, was the first step towards that end. The next should be the enactment of laws requiring their use in such government transactions as will not suffer by the sudden change of the habits of men. There, perhaps, legislation must stop for a long while, until by zealous inculcation, by agitation, by instruction in all public schools, the new system shall have been voluntarily adopted by a great majority of the people, when the enactment of an obligatory law will only be the consummation of an existing state of facts.

It has ever been the practice of the Anglo-Saxon people to make laws in conformity with customs, not to create customs by compulsory laws.

It is indeed difficult to see how an obligatory statute could be executed in this country. We would hardly undertake to suppress the use of the inch, pound, and gallon by penalties, as has been done under the parentally despotic governments of Europe, where, as in Prussia, fine and imprisonment followed the possession of the old standards. It may even be considered doubtful whether the legal mind of the country would approve a statute decreeing that only contracts made in terms of the new standards could be enforced by the courts, since it would violate the principle that any agreement made in good faith can be maintained at law, a principle far more important than conformity in weights and measures with other nations. In attempting answer to the last question propounded by the House resolution, we therefore consider it to imply: How long is it likely to be before the metric system will come into so general use among our people that no hardship will be felt from making it obligatory?

If left to itself its growth would be very slow, and the period necessary might be reasonably estimated at not less than fifty years. The fixing of a time in advance, say the year 1900, would materially aid its growth, and an active propaganda by the friends of the measure, like that initiated by the American Metric Bureau of Boston, would greatly accelerate its general adoption. In view of the very marked effect of the endeavors of that organization, this office would give its opinion that the year 1900 might now be fixed as the time when the use of the metric system should become obligatory throughout the United States. Should our anticipations be deceived such a statute would doubtless be repealed before the time had arrived.

The difficulties attending the adoption of a new system of weights and measures are far greater than is generally thought. The matter presents itself on the surface as a question of preference, involving little more than the mental acquisition of certain terms and their relative values, and the surrender of certain acquired habits. A century ago this would have been a fair statement of the case. At the present time very large pecuniary interests are involved in any change, and oppose it. The work of the world was then done by hand with simple tools, and the only change involved was the use of a metric rule in place of a foot rule. Now that work is mainly done by machinery, the value of which depends in a great degree on the units of measure to which it is constructed, and a great part of it becomes absolute when those units are changed. The great machine-shops devoted to building machine-tools for the construc-

tion of machinery used in the various industries, alone represent values of many millions of dollars, and much of their present "plant" would have to be thrown away and replaced by new, in order to adapt their products to metric units.

Assuming that there were the heartiest common consent to use metric measures in all new machinery, how difficult and long would be the transition? The new thimgs would not fit in the old places. A very large proportion of the work is in supplying worn parts; where then are the dimensions to come in? The immense plant of railway motive-power in the United States is all made to inches and decimals; at what time can a railway company afford to change the dimensions of the parts of a locomotive engine? At no time, it would answer, because the change would require to be simultaneous in the whole stock. It is true that the old dimensions might be adhered to, but called by metric names, putting 0.0254 meters or 25.4 milimeters for one inch, but this would only be an evasion, not a solution of the problem.

The foregoing considerations have been forcibly presented in a communication from our government to other nations, printed in the report on Foreign Relations for 1870, pp. 240–247, in connection with a proposition for assimilating international coinage. In that paper an important reference is made to the terms in which "real estate" is defined in this country. Not only are lands purchased from the public domain described in a simple decimal system of acres measured by square chains and decimals, but all the most valuable real estate, such as lots and streets in cities, has been laid off in this country in even feet, generally even tens of feet, as 50, 60, 80, 100, 150, &c. What adequate motive is there to change these expressions into terms which are necessarily fractional, and in which those foreign nations whose convenience it is proposed to meet have no conceivable interest? What useful purpose is subserved by designating a building lot 24 by 120 feet in the form of 7,315 by 36,576 meters?

It is the foregoing and similar considerations which lead the undersigned to doubt whether the international units of measure will ever wholly take the place of all others in our domestic transactions.

All of which is respectfully submitted.

J. E. HILGARD,
Assistant United States Coast Survey, and Inspector United States Standard Weights and Measures.

C. P. PATTERSON,
Superintendent United States Coast Survey.

Reply of E. B. Elliott, chief clerk Bureau of Statistics.

TREASURY DEPARTMENT, *November* 20, 1877.

SIR: In response to the departmental letter of the 10th instant, desiring me to transmit to the Department, as early as possible, my views upon the several questions submitted in an accompanying resolution of the House of Representatives, in which resolution the heads of the Executive Departments were requested to report to the House what objections there are, if any, to making the metrical system of weights and measures obligatory in all governmental transactions, and how long a preliminary notice should be given before such obligatory use can be introduced without detriment to the public service, and also what

objections there are, if any, to making the metrical system obligatory in all transactions between individuals, and what is the earliest date that can be set for the obligatory use of that system throughout the United States, I have the honor to state that it seems to me desirable that the metric system of weights and measures be made obligatory in certain governmental transactions, chiefly in those of an international character, such as for postal purposes, for the purposes of coinage, and for the assessment of customs-duties.

The metric system for such governmental purposes may, I think, go into operation without detriment to the public service, with the fiscal year commencing July 1, 1879.

It would be well that a tariff schedule of the common and metric equivalents be prepared prior to the full application of the system for customs purposes.

I do not consider it advisable to make the use of the metric system immediately obligatory in transactions pertaining to the transfer of lands, to the collection of internal-revenue dues, or to the internal transactions of the government generally, the changes involved thereby being so numerous and seemingly difficult as possibly to elicit strong protest from many persons engaged in the active pursuits of life with whom the government would have business transactions, and whose immediate interests might for a time be unfavorably affected. Nor do I think it advisable to make the metric system obligatory in the near future in transactions between individuals in the business of private life. Its use is now, by law, permissive between individuals. It may, however, be advisable to render the use of the system obligatory upon the more extended lines of rail and water communications of the country in their operations in regard to freight.

It seems to me advisable that the rendering the use of the metric system obligatory for local and domestic purposes be left, for the present at least, for the action of State legislatures.

I append tables A and B, showing equivalents of the units of the metric and the ordinary systems applicable for customs purposes.

I also append to this communication a copy of the second and third reports, and an extract from the fifth report of the British standards commission—the astronomer royal, George B. Airė, chairman. (See Appendices C, D, and E.)

The second of these reports bears more particularly on the introduction into the country of the metric system of weights and measures, and resulted in several practical recommendations "having for their object the permissive use of the metric system in the United Kingdom, more especially for international purposes."

The third report recommends the abolition of the troy weight, and that the imperial (avoirdupois) and the metric weights be alone authorized to be used. The permissive use of the metric system of weights and measures has been for several years legalized in Great Britain.

The difficulties, if any, which may be apprehended in the substitution of the thoroughly correlated metric system in the international transactions of the government seem to me more imaginary than real, while the advantages to be derived from the introduction for such international purposes of a system which has no rival in respect to simplicity cannot be successfully questioned.

Respectfully,

E. B. ELLIOTT.

Hon. JOHN SHERMAN,
Secretary of the Treasury.

A.—Table for converting certain rates of duty expressed according to units of the ordinary system of weights and measures into their metric equivalents.

$1 per inch	=	$3.93 70	per decimeter.
1 per foot	=	3.28 09	per meter.
1 per yard	=	1.09 36	per meter.
1 per square inch	=	0.15 50	per square centimeter.
1 per square foot	=	0.10 764	per square decimeter.
1 per square yard	=	1.19 60	per square meter.
1 per cubic inch	=	0.06 1025	per cubic centimeter.
1 per cubic foot	=	0.03 531	per cubic decimeter.
1 per cubic yard	=	1.30 898	per cubic meter.
1 per fluid-ounce	=	3.38 134	per deciliter.
1 per pint	=	2.11 336	per liter.
1 per gallon	=	0.26 417	per liter.
1 per proof-gallon	=	0.26 417	per proof-liter.
1 per quart (dry measure)	=	0.90 8	per liter.
1 per bushel (dry measure)	=	2.41 875	per hectoliter.
1 per bushel (32 lbs. avoirdupois)	=	6.89 0	per quintal (100 kilos.)
1 per bushel (56 lbs. avoirdupois)	=	3.93 7	per quintal.
1 per bushel (60 lbs. avoirdupois)	=	2.75 6	per quintal.
1 per grain	=	15.43 2	per gram.
1 per ounce troy (480 grains)	=	0.32 12	per decagram.
1 per ounce avoirdupois (437.5 grains)	=	0.35 27	per decagram.
1 per pound troy (5,760 grains)	=	2.67 92	per kilogram.
1 per pound avoirdupois (7,000 grains)	=	2.20 46	per kilogram.
1 per hundred-weight (112 lbs. avoirdupois)	=	1.96 84	per quintal.
1 per cental (100 lbs. avoirdupois)	=	2.20 46	per quintal.
1 per ton of 2,000 lbs. avoirdupois	=	1.10 23	per millier or metric ton.
1 per ton of 2,240 lbs. avoirdupois	=	0.98 42	per millier or metric ton.
1 per ton of 28 bushels of 80 lbs. avoirdupois	=	0.98 42	per millier or metric ton, or 1,000 kilograms.

EPAMPLES, ILLUSTRATIVE.

Customs duties.

Alcohol: $2 per gallon (or 53 cents per liter).

Ale, beer, and porter, in bottles: 35 cents per gallon (or $9\frac{3}{10}$ cents per liter).

Acetate of ammonia: 25 cents per pound (or 55 cents per kilogram).

Candles, tallow: $2\frac{1}{2}$ cents per pound (or $5\frac{1}{2}$ cents per kilogram).

Carpets, Brussels: 44 cents per square yard (or $52\frac{3}{10}$ cents per square meter), and 35 per centum *ad valorem*.

Hats, of wool, not exceeding 40 cents per pound (or 88 cents per kilogram): 20 cents per pound (or 44 cents per kilogram), and 35 per centum *ad valorem*.
above 40 cents per pound (or 88 cents per kilogram), and not exceeding 60 cents per pound (or $1.32 per kilogram): 30 cents per pound (or 66 cents per kilogram), and 35 per centum *ad valorem*.

Pig iron: $7 per ton (or $6.88 per metric ton or quintal).

B.—*Table of existing rates of duty on glass, expressed in metric units.*

Greatest dimensions in square decimeters.	Contents in square decimeters.	Descriptions of glass and rates of duty.				
		Fluted, rolled, or rough plate, per square decimeter.	Unpolished cylinder crown, and common window, per kilogram.	Polished cylinder and crown, per square decimeter.	Cast polished plates, unsilvered, per square decimeter.	Silvered looking-glass plates, per square decimeter.
1	2	3	4	5	6	7
		Mills.	*Cents.*	*Mills.*	*Mills.*	*Mills.*
2.540 (10 inches) by 3.810 (15 inches).....	9.678	¾	3	2½	3	4
4.064 (16 inches) by 6.096 (24 inches)....	24.774	1	4	4	5	6
6.096 (24 inches) by 7.620 (30 inches).....	46.452	1½	5	6	8	10
All over	All over.	All over.	6	....	....	....
6.096 (24 inches) by 15.240 (60 inches)....	92.903	2	....	20	25	35
All over	....	....	....	40	50	60

To the foregoing rates of duty add, in column 4, *one-tenth*, and in columns 3, 5, 6, and 7, three-fortieths, of such rates.

N. B.—All fluted, rolled, or rough plate-glass weighing over 100 pounds per square foot must pay an additional duty on the excess at the same rates as above, and on looking-glass plates or plate-glass silvered, *when framed*, there is a duty of 30 per cent. ad valorem on the frames in addition to the above rates.

C.—*Standard commission.*

SECOND REPORT.

To the Queen's Most Excellent Majesty:

May it please Your Majesty: We, the commissioners appointed under Your Majesty's royal warrant dated the 4th day of May, 1868, for inquiry into the condition of the exchequer standards (now called the board of trade standards or the official standards) of length and weight, and for other purposes therein set forth, acting under the directions to us contained in the said warrant, to report to Your Majesty from time to time the result of our inquiries, humbly offer to Your Majesty our second report.

1. In closing their first report, submitted to Your Majesty under date of 24th July, 1868, the commission adverted to the metric system, and especially to the probable effect of attempting to introduce it into this country. This subject appeared to enter legitimately into their consideration, inasmuch as the introduction of a new system would imply addition to the existing board of trade standards, to which (among other things) the inquiries of the commission are by Your Majesty's royal warrant specially directed, and the commission expressed their sense of the great importance of the question, and undertook to give to it their early and careful attention.

2. In their desire to redeem this pledge the commission have thought it advantageous to confine themselves in this their second report to the questions connected with the metric system, deferring to a later report all allusion to the various points connected with the proceedings of the standards office, and with the British law and its administration relating to the imperial system of weights and measures.

3. It appears to the commission that the reasons which may be urged for or against the introduction of a new system will naturally arrange themselves under two heads, namely, those which relate to the internal commercial transactions of the country, and those which relate to transactions with other countries. It is proposed here to consider the subject in that order.

4. With reference to the question as bearing upon internal commerce, the commission have thought it desirable to examine into the reasons assigned for changes of system in other countries, and, if possible, to ascertain the results of their experience; and to inquire whether similar reasons apply, and what may be anticipated as the effect of change in this country.

5. As regards the first of these trains of inquiry, the commission have derived most valuable information from official papers of other countries, transmitted either directly or through the board of trade to the warden of the standards, and by him communicated to the commission. The information thus laid before them is appended to the report. Among these documents the most important are those of France, the United States of North America, North Germany, Switzerland, and India. As regards the second inquiry, the commission have had before them the evidence collected by preceding standards commissions, and especially that which was heard by a committee of the House of Commons in the year 1862; they have also had the results of their own personal experience, both in matters of science and in transactions of daily life.

6. The commission remark that in the statements introductory to the proposals for new systems in France, North Germany, and India, very great stress is laid upon the discordance in the fundamental units of their customary weights and measures, as adopted in different districts of the same empire. These reasons have no force in Great Britain and Ireland, throughout which, whatever difference may prevail as to the multiples in local use, the fundamental units, namely, the yard, the pound, the gallon, are strictly the same—based upon national standards which are constructed with the utmost skill and care, and supported by a system of inspection which, though chargeable with imperfections (to which the commission at present advert no further), is, on the whole, efficient. The commission also remark that, in the introduction of the new system into Switzerland, it appears to have been rather the object of the proposers to define accurately the relation of their standard to the French standard than to adopt the metric system; thus the Swiss foot is defined to be three tenths of the metere (*sic*), a proportion which seems to be irreconcilable with the practical adoption of a decimal scale.

7. On the results of the introduction of the metric system, as matter of experience, it is difficult to give a certain statement. The great mass of people in France undoubtedly adopt it, both in the names and in the values of the weights, measures, and coins; although such names as the *livre* and the *sou*, for the half kilogram, and the piece of five centimes, are still in common use. In Holland and other neighboring countries the metric system, though very generally adopted, is, it is believed, still less perfectly introduced.

8. In the United Kingdom, so far as can be conjectured, the existing imperial system has, in its main features, grown up spontaneously among the people, and the action of the legislature has been limited to such practical measures as the following: the giving certainty and precision to the fundamental standards; the establishment of accurate and more simple relations among systems which at first probably had no

connection (as those of the stone and the pound), and, in some instances, the abolition of measures, &c., which, while bearing the same name, had slightly different values (as the various gallons). If this conjecture be correct, it tends to prove that the existing system meets the popular wants, and that it will not easily be expelled from popular use.

9. There is good reason to believe that in large factories a decimal division is frequently convenient, and in many cases, for commercial reasons, the most convenient base for that division is the metric. The owners of those factories can, however, arrange such matters, to a great extent, without legislative assistance. But for sales in shops, which specially require the care of the legislature, and for ordinary work, other considerations apply. Different bases must be adopted; for instance, the yard is a very convenient length for drapers' measure, but the foot is far more convenient for carpenters' measure. It has been remarked that the last or coomb, the bushel, and the peck are well suited for men's backs, arms, and hands. The natural inclination of the mind to halve and quarter continually exhibits itself in the subdivision of almost every base; thus in avoirdupois weights and in measures of capacity, the progressive halving of the pound and bushel, and their lower denominations, is continued nine times, and the binary subdivision extends to $\frac{1}{512}$. The metric system does not offer the same facility either for change of the adopted base, or for the continued binary subdivision; and any attempt to force it into use in shops, and into workmen's operations and their accounts, would probably be felt as a needless grievance.

10. The commission are obliged to remark here that the evidence as to the feeling of the great class of venders in shops and ordinary tradesmen is rather of an inferential than of a positive character. Among the witnesses examined by the committee of the House of Commons which sat in 1862, there is not one shopkeeper, and scarcely one person of the lower working class. The evidence collected by the preceding standards commissions cannot fairly be cited now, as the question of introducing the metric system into this kingdom had then hardly been raised. But the commission cannot omit to call attention to the distinct though negative fact, that not a single movement has been made on the part of shopkeepers or workmen for procuring a change, and not a single complaint has been made by them of the existing legal system of imperial weights and measures.

11. It is obvious that in this country, where the people are more accustomed to self-government than in other European countries, the executive has far less power of compelling obedience to the law in all the small transactions of trade, against the wishes of the public. Should an attempt be made at the present time to introduce the metric system by legal compulsion, the commission regard it as certain that very great confusion would be produced, and they think it highly probable that the attempt would be met by such an amount of resistance, active and passive, that it would totally fail.

12. At the same time the commission remark that the want of weights and measures on a decimal scale generally, or on the metric scale specifically, is not unfrequently felt by the manufacturing and trading classes, and more especially by men of science and by chemists and engineers of the highest class; and that it appears scarcely possible to satisfy this want, and to place the metric system on the footing which it seems justly to claim, except by the legal establishment of metric standards and of inspectors' standards (where required), and by the legal sanction of the use of metric weights and measures in shops and in offices of conveyance. But such permission, unless very carefully guarded, would lead to the most intolerable and enduring confusion, and the

commission expressly state their opinion that any enactment giving permission to use metric weights and measures for public sales and conveyance must be accompanied with such provisions for their form or other characteristics as will make it impossible to mistake them for weights and measures of the existing imperial system. With very careful attention to these provisions, the commission see no objection to the permissive introduction of weights and measures on the metric system into shops and offices of conveyance, provision being also made for inspectors' standards and powers of inspection, where required.

13. With the view of further lessening any confusion that might be occasioned by the addition of a new series of weights to those now existing of the avoirdupois and troy scales, the commission have had under their consideration the question of the discontinuance of troy weight. They refer to the opinions expressed by the standards commissions of 1841 and 1854, in favor of the simplification of the British system of weights by the abolition of the troy scale. Apothecaries' weight, based on troy weight, has since been legally discontinued under the authority of the medical act, 1858, and avoirdupois weights have been substituted in the dispensing of medicines. Much of the difficulty of the discontinuance of troy weight is thus removed, its use being now limited to manufacturers of and dealers in gold and silver wares and bullion. Still these form a numerous class, and the commission feel that they cannot make any definite recommendation for abolishing troy weight without having first inquired extensively into the practice and feelings of persons who now use that system. The assay of the precious metals, the ascertaining the standard of gold and silver, the operations of coinage, and the levying the duty on gold and silver plate, all are now based by statute on troy weight; and in the event of its abolition, it will become necessary to make further provision by law for the weights to be used for these purposes. It may also be a matter deserving consideration how far it may be expedient to substitute metric weights. The commission will give their careful attention to these points, and the results of their labors must be deferred to a future report.

14. Passing now to the consideration of our transactions with foreign countries, the commission express their full belief that the foreign commerce of this country, especially with France and with other countries which have introduced or propose to introduce the metric system, has in late years increased much more rapidly than the home trade, though in what proportion it is difficult to ascertain. But, great as that foreign commerce undoubtedly has become, it is small in comparison with the home trade. From the report of the postmaster-general in the year 1864, it appears that the number of foreign letters (requiring apparently to be doubled for proper comparison of the number of transactions) was about one-fiftieth of the number of home letters. If we refer to the accessible returns relating to money transactions, the amount of stamp-duty levied on foreign bill stamps, about £350,000 annually, implies foreign transactions to the amount of £600,000,000; while the amount of checks and bills passed at the London Clearing House (in which many of the London bankers take no part) is about £3,300,000,000, and the transactions in the manufacturing districts and the interior of the country generally multiply this in an unknown ratio. Still, the existence of this large foreign trade is an argument for the permissive adoption of the system which agrees with that of so many of our foreign-trade correspondents; and great advantage will evidently be introduced, unaccompanied (so far as can be remarked) with any bad effects, by giving the ordinary statistical publications relating to foreign trade, and

in some instances to home trade also, on the metric as well as on the imperial system.

15. As bearing upon all parts of this inquiry, the commission think it their duty to call attention to the advantage of establishing in this country a decimal system of coinage. The decimal division gives the greatest facilities for the gradation of prices, and for the great number of additions, multiplications, and divisions continually presenting themselves in money affairs, but more rarely occurring in the combination of the several denominations of weights and measures, and the commission think it probable that extensive familiarity with decimal coinage would materially tend to facilitate the introduction of a decimal scale of weights and measures, where it can be useful. The commission do not disguise their apprehension that a change of coinage would produce for a time some confusion. At the same time they observe that it is absolutely in the power of the government to effect the change without any risk that the resistance which might be made by those who preferred the old system could ultimately prevail against it.

16. Guided by the preceding considerations, the commission have unanimously agreed upon the following resolutions:

(1.) Considering the information which has been laid before the commission: of the great increase during late years of international communications, especially in relation to trade and commerce; of the general adoption of the metric system of weights and measures in many countries, both in Europe and other parts of the world, and more recently in the North German Confederation and in the United States of America; of the progress of public opinion in this country in favor of the metric system as a uniform international system of weights and measures; and of the increasing use of the metric system in scientific researches, and in the practice of accurate chemistry and engineering construction, we are of opinion that the time has now arrived when the law should provide, and facilities be afforded by the government, for the introduction and use of metric weights and measures in the United Kingdom.

That for this object metric standards, accurately verified in relation to the primary metric standards at Paris, and deposited in the standards department of the board of trade, should be legalized; and that verified copies of the official metric standards should be provided by the local authorities for inspectors of such districts as may require them.

(2.) Considering the advantages of adopting in an international system not only of uniform weights and measures, but also uniform names, and that although there may be well-founded objections to the inconvenient length and occasional similarity, both to the eye and ear, of the French nomenclature, yet it is probable that these names will become familiar by custom, and obtain popular abbreviations.

We think that the French nomenclature, as well as decimal scale of the metric system, should be introduced in this country.

(3.) Considering that there is no immediate cause requiring a general change in the existing system of legal weights and measures of the country for the purposes of internal trade; that the statutable values of the fundamental imperial units are adopted in use without the slightest variation throughout the whole of the British Isles; that the primary imperial standards are as perfect as can be made by modern skill and science, and that the whole series of official standards are now most accurately verified in relation to the primary standards; that a very large number of copies of the official imperial standards, accurately verified, are now in use by the local inspectors of weights and measures; that it is estimated there are nearly thirty millions of ordi-

nary weights and measures of the existing imperial system now in common use; that at the present time there is no evidence to show that any considerable portion of traders and their customers in this country are dissatisfied with the imperial system now in use, or that they desire to substitute the metric system for it, we are of opinion that the general introduction of the metric system should be permissive only, and not made compulsory by law after any period to be now specified, so far as relates to the use of metric weights and measures for weighing and measuring goods for sale or conveyance.

(4.) Considering that during the concurrent use of the metric and imperial systems it will be expedient to prevent as far as possible imperial and metric weights and measures from being accidentally or fraudulently substituted for each other, we are of opinion that authoritative regulations should be established, under which each series may be readily and easily distinguished, by the adoption of conspicuous distinctive forms or marks for the several weights and measures, and by such mode as may be determined upon after due inquiry.

(5.) We are of opinion that it is expedient that customs duties should be allowed to be levied by metric weight and measure, as well as by imperial weight and measure; that the use of the metric system concurrently with the imperial system should be adopted by other public departments, especially the post-office, and in the publication of the principal results of the statistics of the board of trade, as well as for the admeasurement and registration of the tonnage of shipping.

(6.) And that mural standards of the metric system, as well as of the imperial system, be exhibited in public places.

(7.) Considering that the metric system, as adopted in other countries, includes the relation of coinage to weights and measures, particularly in its uniform decimal scale, and that the advantages of the introduction of the metric system into this country as an international system of weights and measures would be much increased by establishing a corresponding international system of coinage, in regard to a unit and to a decimal scale, we are of opinion that, even if the difficulty of establishing an international unit of coinage cannot be at present overcome, yet the decimalization of our system of coinage, which is in the power of the government, would be very useful to the public.

(8.) Considering the great national importance of the question of the introduction of the metric system of weights and measures into this country, it appears to us essential that any measure for this object should be proposed to Parliament by the executive government.

(9.) Considering that the commission will very shortly enter upon the questions referred to them relating to the system of local inspection of weights and measures throughout the United Kingdom, we are of opinion that it is expedient that no legislation should take place with respect to the metric system until the whole subject of the weights and measures of this kingdom be brought before Parliament in one bill.

All which we humbly submit to Your Majesty.

G. B. AIRY, *Chairman.*
COLCHESTER.
STEPHEN CAVE.
JOHN GEORGE SHAW LEFEVRE.
EDWARD SABINE.
THOMAS GRAHAM.
W. H. MILLER.
H. W. CHISHOLM.

7 OLD PALACE YARD,
April 3, 1869.

D.—*Standards commission.*

THIRD REPORT.

The Queen's Most Excellent Majesty:

We, the commissioners acting under Your Majesty's royal warrant dated 4th May, 1868, for inquiry into the condition of the exchequer standards (now called the board of trade standards or the official standards) of length and weight, and for other purposes therein set forth, in pursuance of Your Majesty's commands to report to Your Majesty from time to time our several proceedings by virtue of the said commission, humbly offer to Your Majesty our third report.

1. Among the duties intrusted to us by Your Majesty, we have been directed to inquire and to report whether any and what additions to the existing board of trade standards are now required, and if any and what existing standards should be discontinued and cease to be secondary standards. In our second report, dated 3d April, 1869 (S. 13), we submitted to Your Majesty that we had under consideration the question of the discontinuance of troy weight, and how far it may be expedient to substitute metric weights; and that after we should have inquired extensively into the practice and feelings of persons who now use the troy system, we proposed to state the result of our labors in a future report.

2. In the papers appended to this report will be found all the information accordingly laid before us upon the subject, including the evidence of several witnesses selected by us as fairly representing the classes of persons whose interests were deemed to be involved in the continuance or abolition of troy weight.

3. After mature consideration we have come unhesitatingly to the conclusion that it will be for the public advantage to simplify the imperial system of weights by legislative provisions for the abolition of troy weight.

4. There appears to be no trustworthy record of the origin of the troy system, the abolition of which is now recommended. The troy pound is said to have been derived from the Roman weight of 5759.2 grains, the 125th part of the large Alexandrian talent; this weight, like the troy pound, having been divided by the Romans into twelve ounces. The earliest statute of this kingdom in which troy weight is named is the 2 Henry V, St. 2, c. 4, for preventing an excessive charge for gilding silver wares, in which it is enacted that all the goldsmiths of England shall gild no silver worse than that of the alloy of the English sterling, and that they shall take for a pound of troy gilt ("*pur la libre de troy orre*") but 46*s.* 8*d.* at most. But troy weight is universally allowed to have been in general use from the time of King Edward I. The most ancient system of weights in this kingdom was that of the Moneyer's pound, or the money-pound of the Anglo-Saxons, which was continued in use for some centuries after the conquest, being then known as the tower pound, or sometimes the goldsmiths' pound. It contained twelve ounces of 450 grains each, or 5,400 grains, and this weight of silver coins was a pound sterling. The tower pound was abolished in 1527, by a statute of Henry VIII, which first established troy weight as the only legal weight for gold and silver. This statute was as follows: "And whereas, heretofore, the Merchante paid for coynage of every Pounde Towre of fyne gold, weighing XI oz. quarter Troye ii*s.* vi*d.*: Nowe it is determined by the King's Highness and his Councille that the aforesaid Pound Towre shall be no more used and occupied, but al maner of

golde and sylver shall be wayed by the Pounde Troye, which maketh xii oz. Troye, which exceedeth the Pounde Towre in weight iii quarters of the oz." From this time to the present, our system of coinage has been based on troy weight.

5. The reasons upon which we have come to the determination that troy weights should now be abolished by law, and other weights substituted, will be found in the following resolutions, which have been unanimously passed by us:

(1.) Considering—

That in the report of the standard commission of 1841 and 1854 opinions have been expressed in favor of the simplification of the imperial system of weights by the abolition of troy weight;

That troy weight has since been legally discontinued for pharmaceutical purposes, and avoirdupois weight substituted under the provisions of the medical act, 1864;

That troy weights are now used only for the precious metals and for trade purposes by manufacturers and dealers in gold and silver wares;

That the troy weights so used for trade purposes appear to be the old nest set of ounce weights, increasing in a binary series up to two hundred and fifty-six ounces, according to the old standards established by Queen Elizabeth in 1588, which ceased to be the legal standards in 1824; and that the existing legal denominations of troy weights, as represented by the official standards, are not generally used;

That the decimal series of troy ounces for bullion, legalized in 1853, has never been adopted by the general public;

That it has been shown to us that throughout the United Kingdom only eight counties and thirteen cities and towns are furnished with legal copies of the official troy standards, and two counties and five cities and towns with legal copies of the official decimal bullion standards;

That the legal provisions for stamping and inspecting troy weights throughout the country have been practically inoperative;

That the legalization of the use of metric weights has been recommended by us in our second report, and the concurrent use of three distinct systems of weights will be inexpedient, and tend to produce confusion and complication, more especially as regards the local inspection of weights and measures, as, in the event of the continuance of the troy system, it would be requisite to provide for an equally vigilant inspection of troy weights as of other weights;

That we have satisfied ourselves, from the evidence of various classes of persons now using troy weight in business transactions, that there are no sufficiently valid reasons for the continuance of troy weight which can be placed against the great advantage to the public of simplifying our system of weights by its abolition:

We are of opinion that it is expedient that the use of troy weights be abolished by law.

(2.) We therefore recommend that legislative provision be made that from and after twelve months from the passing of an act for that purpose—

The provisions of the act 5 Geo. 4, c. 74, for ascertaining and establishing uniformity of weights and measures, and of 16 Vict., c. 29, for regulating the weights used in sales of bullion, and of any other act or acts legalizing or requiring the use of troy weights, so far as they relate to the same, shall be repealed.

All secondary standards of troy weight now deposited in the stand-

ards department of the board of trade shall cease to be legal secondary standards.

All copies of such secondary standards of troy weight, verified for the use of local inspectors of weights and measures, shall cease to be legal standards.

The use of all troy weights in shops and places where goods are exposed or kept for sale shall be illegal, and all troy weights found there shall be liable to be seized and forfeited, and the person in whose possession they are found shall, on conviction, be liable to a penalty not exceeding £5.

All contracts for buying and selling made in terms of troy weight shall be void.

Such provisions to apply to all weights and measures used for pharmaceutical purposes; and that it be expressly declared that the powers of regulating the weights and measures to be used in pharmacy, granted to the general medical council under the medical act, 1858, be limited to legal denominations of weights and measures for which standards are provided by law.

(3.) We recommend that for a period of ten years after the passing of the act the use of troy weights for the internal operations of manufactories and workshops, not subject to the visits of inspectors of weights and measures, be permitted, and that no contract or agreement between a master and workmen, or between a wholesale and retail dealer, be illegal in consequence of its being made in reference to troy weight.

But that after the expiration of ten years from the passing of the act, the same provi ions shall be applicable to such troy weights as to those specified in section 2.

(4.) Considering—

That the several operations connected with the gold and silver coinage, the purchase of bullion, and the assay of the precious metals are frequently carried on with relation to business transactions with foreign countries, and, as such, are matters of international trade;

That we have had the evidence of the late Master of the Mint that the substitution of the metric system of weights for the troy system, and of the decimal system of assay for the grain and carat system, would be attended not only with no difficulty as regards the mint, the Bank of England, and the bullion trade, but with advantage to the public;

That from the evidence produced before us we have reason to believe that no valid objections or practical difficulties exist to such substitution:

We recommend that legislative provision be made that, in all cases where specified weights of the troy system are recited in any existing act of Parliament, and relate to the weight or fineness of the gold or silver coinage or of bullion, the nearest equivalent metric weights, according to a table of equivalents to be contained in a schedule annexed to the act, be substituted.

And we also recommend that in all statements of assays of gold and silver bullion upon which any legal contracts can be based, the millesimal or centesimal system of assay be substituted for the grain and carat system.

(5.) With regard to troy weights specified in statutes relating to duties on gold and silver plate and on licenses for dealers in gold and silver plate—

We think that it may be sufficient that due legislative provision be made to enable the inland revenue department to substitute either avoirdupois or metric equivalents, or the nearest integral equivalents

that may be deemed expedient, until such time as a legislative change may be made in the amounts of these duties for fiscal objects.

In the assessment of customs-duties on gold and silver plate imported into this kingdom from other countries, we recommend the substitution of similar equivalents of metric weight.

(6.) As to the weights to be substituted for those of the troy system now used by the general public and for purposes of manufacture and trade;

Considering—

That we have stated our opinion in our second report that the general introduction of the metric system should be permissive only, and not made compulsory by law, after any period to be now specified, so far as relates to the use of metric weights for weighing goods for sale or conveyance; and that authoritative regulations should be established by which each series of weights may be readily and easily distinguished by the adoption of conspicuous distinctive forms or otherwise;

That it will be a sufficient hardship upon those persons who now use troy weights to be compelled to give them up, although for the general advantage of the public; and it will be manifestly unjust, also, to compel them to substitute metric weights while all other classes of the community are under no obligation to abandon their avoirdupois weights and are allowed the option of using metric weights;

That the grain and its multiples and parts, formerly weights of the troy system, were made avoirdupois weights by the provisions of sections 3 and 4 of the act of 1853, for legalizing the restored standards of weights and measures, and will in future be legal weights of the avoirdupois scale only;

That a decimal series of grain weights has been recommended in our first report to be legalized as official standards; and such series from 0.01 grain to 1,000 grains, and additional weights of 2,000 and 4,000 grains, have been constructed and have been most accurately verified in the standards department in order to serve as legal standards and for verifying copies for the use of local inspectors of weights and measures, in order that the public may be supplied with weights of this description duly correct:

It appears to us that upon the abolition of troy weight, all those persons who now use it, either for manufacturing, trading, or other purposes, should be permitted to substitute either avoirdupois or metric weights, and that every facility should be afforded to them for this object.

That for all ordinary purposes, the substitution of the avoirdupois pound, ounce, and dram, with their multiples and subdivisions, to the half dram, will suffice for those persons who may wish to substitute the avoirdupois scale.

That for all such persons who may require more minute accuracy in their weighings, the use of decimal grain weights will meet their requirements.

That such grain weights for public use should be constructed of a distinctive form or material, so as to be readily distinguishable from other nearly equivalent weights.

(7.) We are of opinion that any legislation for carrying into effect the objects of these resolutions should be comprehended in the bill to be proposed to Parliament by the executive government for the amendment of the weights and measures laws, as recommended in our second report.

6. In the minutes of evidence herewith submitted to Your Majesty,

bearing upon the question of the abolition of the troy scale, and upon the present use of troy weights, much information will also be found relating to the system of inspection of weights and measures now established, and to suggested improvements in this system, including the relation of the standards department of the board of trade to the local inspectors of weights and measures. We have completed our inquiries into this large and important question, and hope very shortly to submit to Your Majesty the results of our deliberations in our next report.

We have to lament the loss of one of the members of the commission, Mr. Graham, late master of the mint, who died on the 16th September, 1869.

All which we humbly submit to Your Majesty.

G. B. AIRY, *Chairman.*
COLCHESTER.
STEPHEN CAVE.
JOHN GEORGE SHAW LEFEVRE.
EDWARD SABINE.
W. H. MILLER.
H. W. CHISHOLM.

7 OLD PALACE-YARD, *February* 1, 1870.

D.—*Extract from the fifth report of the Standards Commission*, 1871.

* * * * * * *

Our second [report] bore more particularly on the question of the introduction into this country of the metric system of weights and measures, and embodied the results of our inquiries and deliberations and several practical recommendations, having for their object the permissive use of the metric system in the United Kingdom, more especially for international transactions.

The abolition of troy weight was the subject of our third report, in which we referred to such legislative provisions as appeared to us to be requisite in carrying out our recommendations for the simplification of the imperial system of weight.

ADOPTION OF METRICAL SYSTEM.

LETTER

FROM THE

SECRETARY OF THE INTERIOR,

TRANSMITTING,

In response to a resolution of the House of Representatives, reports concerning the adoption of the metrical system of weights and measures.

May 6, 1878.—Referred to the Committee on Coinage, Weights and Measures and ordered to be printed.

DEPARTMENT OF THE INTERIOR,
Washington, D. C., May 4, 1878.

SIR: In reply to a resolution of the House of Representatives, passed on the 6th of November, 1877, requesting the heads of the executive departments of the government to report what objections, if any, there are to making the metrical system of weights and measures obligatory in all governmental transactions and also in all transactions between individuals, I have the honor to transmit herewith reports upon the subject from the Commissioner of the General Land Office, the Commissioner of Patents, the Commissioner of Education, Professor F. V. Hayden, and Major J. W. Powell.

Very respectfully,

C. SCHURZ,
Secretary.

Hon. SAMUEL J. RANDALL,
Speaker of the House of Representatives.

DEPARTMENT OF THE INTERIOR,
GENERAL LAND OFFICE,
Washington, D. C., March 2, 1878.

SIR: I have the honor to acknowledge the receipt of a copy of a resolution of the House of Representatives, dated November 6, 1877, which has been referred by you to this office for report.

Under the resolution referred to, heads of executive departments of the government are requested to state "what objections there are to making obligatory in all governmental transactions the metrical system

of weights and measures whose use has been authorized in the United States by act of Congress, and also how long a preliminary notice should be given before such obligatory use can be introduced without detriment to the public service;" * * * "what objections there are, if any, to making the metrical system obligatory in all transactions between individuals; and what is the earliest date that can be set for the obligatory use of the metrical system throughout the United States."

Assuming that this office is expected to report upon questions connected with the application of the *meter*, as already established by law, in determining distances and areas in the prosecution of the public land surveys, I have given that part of the subject careful consideration.

The system now in use in surveying and subdividing the public lands, with the modifications that have been suggested by experience, has controlled the public land surveys for a period of ninety years. Under it some seven hundred millions of acres, lying in twenty-eight States and Territories, have been surveyed, and of these many millions of acres remain undisposed of.

The aggregate quantity of unsurveyed public lands in eleven partially surveyed States and Territories, and in the wholly unsurveyed Territory of Alaska, is about equal to that already surveyed.

The modifications which would necessarily follow the adoption of the meter in place of the unit of measure now in use would mainly affect the subdivisional work, by requiring the use of the *centare*, *are*, and *hectare* in superficial measures, instead of the acre, which is the sole unit of superficial measure now in use in land surveys.

As the unsold lands are mingled with those already disposed of and patented, they cannot be resurveyed. Without resurvey, they must be disposed of as now subdivided. If the proposed obligatory law should go into effect, it is evident that the labors of this office in disposing of lands, the subdivisions of which are governed by two different systems, must be very considerably increased.

The Gunter chain, so long used in this branch of the public service, is of the convenient length of 66 feet. It furnishes a unit of linear measure twenty times greater than that of the metric system—a unit that accords with the magnitude of the operations in which it is employed. This measure is readily adapted to ancient surveys, in which the pole or perch was used. It determines the statute mile without division of its parts.

Wherever the public land surveys extend they furnish the public with convenient reference in determining distances by miles and parts of a mile from point to point, and their monuments are referred to in all proceedings relating to the location and construction of public roads.

The 80 chains of the mile divide into suitable parts without fraction, and the subdivisions of lands produced thereby are equally free from the disadvantage of fractional parts of the acre.

Where from natural causes fractional subdivisions become necessary, their areas are readily determined by the Gunter chain and its decimal parts.

The legal township of the United States land surveys is approximately a rectangular tract, with sides of six statute miles. This body of land is divided into 36 sections, with sides of 80 chains, each regular section embracing, as nearly as may be, a square mile, or 640 acres.

In setting off the aforementioned tracts by the metric system, the sides of the township—six miles—would measure 9 kilometers, 6 hectometers, 5 decameters, 6.083 meters.

The sides of the system—80 chains—would measure 1 kilometer, 6 hectometers, 9.347 meters.

The contents of a section, now briefly expressed "640 acres," would be 258 hectares, 99 ares, 98.41 centares.

The contents of the convenient and briefly-described quarter-section of 160 acres, expressed in terms of the metric system, would be 64 hectares, 74 ares, 99.6 centares.

Inferior subdivisions would, of course, be alike burdened with a multiplicity of terms, which, owing to the diminutive unit of the metrical system, can only be determined by comparatively laborious calculations.

The use of the subdivisions inferior to the hectare would in some respects resemble a return to the long-discarded "rood" and "perch" formerly recognized as subdivisions of the acre.

The effect of the immediate adoption of the meter in land surveying would be to place eleven States and Territories in the condition of having their lands subdivided under two systems widely differing in character, with units so difficult of conversion one to the other as to cause much trouble and liability to error in the transactions of business based upon land areas.

It has been claimed that the application of the proposed system of weights and measures will greatly facilitate commercial operations, more particularly the disposition of articles of export.

While this may be true, similar advantages cannot be expected from such an application at this late day to surveyed and permanently-marked subdivisions of the earth's surface, the titles to which, for ages to come, must be traced from time to time, by description, back to their origin. This class of evils will be increased in number by the ordinary changes connected with additions to and partitions of estates.

It may be asserted that some of the disadvantages of fractional linear and superficial measure can be averted by the substitution of a township of different dimensions from that now legalized, but such action, aside from other inconveniences, would involve the expense of retracement of many standard and meridian lines now marked in the field to suit the present subdivisional system.

It will, I trust, be seen from the foregoing that the substitution of the meter for the convenient unit now used in land surveys is not likely to promote the interests of this branch of the service. On the contrary, the effect will be to increase its labors and expenses, and to cause great inconvenience to the public for many years to come, and these embarrassments seem to be unbalanced by any corresponding advantage.

Governed by these views, and without desiring to influence opinion as to the effect of the proposed obligatory law in other departments of the public service, I would respectfully suggest the propriety of exempting the public land surveys from its operations.

If, however, it should be deemed inexpedient to make such exemption, I would further suggest that a period of three years from date of passage of the proposed obligatory law be allowed this branch of the service in which to make suitable preparations in field and office to meet the demands of the new system.

The aforementioned copy of the House resolution is herewith returned.

I have the honor to be, very respectfully,

J. A. WILLIAMSON,
Commissioner.

Hon. CARL SCHURZ,
Secretary of the Interior.

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE,
Washington, D. C., March 14, 1878.

SIR: I have the honor to acknowledge the receipt of resolution of the House of Representatives of November 6, 1877, transmitted by you for report January 17. The resolution calls for a report—

First. Upon the objections, if any exist, to making obligatory in all government transactions the metric system of weights and measures, and how long notice should be given before such obligatory use can be introduced without detriment to the public; and, second, as to the objections, if any exist, to making the metric system obligatory in all transactions between individuals, and the earliest date that could be set for its obligatory use throughout the United States. It should be remarked that, so far as the business of this office is concerned, the whole question is one of very little moment.

Measurements of weights and quantity, it is true, sometimes are an important factor in inventions relating to chemical processes and composition of matter; but as such quantities are in office practice always proportionate, it is of no consequence whatever what system of measurement is used. The proportion of two to one is clear and precise, and the same under all systems.

I assume, therefore, that a report is desired from me rather as a possible expert on matters closely affecting the whole range of arts and sciences, and I shall consider the question as one of public concern, entirely outside of the interest of this office.

In the first place, the formal statement of the resolution, whereby it is proposed to consider separately the interests of the government and of the public generally upon this question, appears to be an unfortunate one. The mutual interests of the government and people, as instanced in the work of the Post Office and of the General Land Office, are not to be separated. The dealings of the government with the public in the purchase of supplies for the Army, Navy, Indian Bureau, and all its departments, are interminable, and the use of a particular system of weights and measures in ordinary commercial transactions by the government makes its use among the people unavoidable. Some delay might occur before its use would become universal in transactions between individuals, but the abandonment of the old system, however popular, would be only a question of time. In fact, the only practicable means, in my opinion, whereby the adoption of the new system by the people of the United States could be accomplished would be by making its use obligatory in all government transactions.

The general question as to the practical advantages of the metric system over those now in use in English-speaking countries has been urged for many years. It is enough to say that almost the sole advantage claimed for it is the facility of calculation resulting from its decimal character. To a full appreciation of this advantage the people of the United States may be considered committed by the adoption of their decimal currency, which for convenience apparently leaves nothing to be desired.

It may fairly be questioned, however, whether a system which admits of decimal divisions only possesses special advantages beyond mere facility of calculation. The division into halves and quarters has been found indispensable in our coinage. It is a natural division, which the mind readily grasps, and in its subdivisions is more readily appreciated than the division by tenths, hundredths, and thousandths. If we have

a clear conception of the length of one yard, we readily grasp the idea of two yards, but can hardly intelligently grasp that of ten yards; and the reverse is strictly true. The mind does not readily vault over the wide intervals that the decimal system demands.

Hence, while from the nature of our numerical notation the use of a decimal system facilitates calculation, its advantages over others in all practical operations are subject to question, and until these advantages have been most emphatically demonstrated, I should be slow to recommend that the use of the metric system be made obligatory upon the American people. Our commercial transactions, other than domestic, must always be largely with other English-speaking people, who use the same systems with ourselves, and I cannot believe it advantageous to make such a radical change as this resolution suggests except with the concurrence and concerted action of Great Britain and her colonies.

These objections to the use of the metric system in the ordinary transactions of life are, however, of trifling importance compared with others, which seem almost insurmountable. It matters little by what system of weight or measure we buy or sell our sugar or coffee, or silk or calico; the transaction is quickly at an end; and the comparative convenience of one system rather than another is, in most cases, a matter of habit only. A versatile people might quickly enough accustom themselves to the use of any ordinarily convenient system for such transactions as these; but transactions which involve the title to valuable property, and become matters of record, which are perpetuated from one generation to another, present quite a different aspect.

The history of the Mississippi Valley affords a practical illustration of the difficulty of substituting one system of land-measurement for another. It is well known that the early French settlers of Saint Louis and vicinity laid out their land in *arpents*, the arpent being somewhat less than an acre, and the common unit for land-measurement in use among them. Since that time, the territory has passed from French into Spanish hands, and from Spanish to our own. It has been for nearly three quarters of a century American soil. The French settlers have become merged with the emigrants from the East and Europe that have filled the Mississippi Valley. Old customs have disappeared, and the few lingering reminders of French occupation are cherished by the antiquarians with almost as much tenderness as if they were relics of Assyria or Babylon. But to-day there is scarcely a piece of real estate in the vicinity of Saint Louis that is not measured in arpents. It is so advertised, so sold, and this word lingers in the speech of the people, and the area it indicates lingers in their daily transactions with a tenacity that nothing appears to shake. Now there is nothing in the arpent which makes it a more convenient unit of measurement for land than the acre. But its retention under the circumstances is something more than a question of mere habit or use. It is because all real estate transactions are matters of permanent record, and permanent records are only changed with great difficulty. To change them involves translation, tedious and accurate computation, the discarding of original records, and opens the door to mistakes and fraud; and the possibilities of these are without end.

For a little district of a few square miles along the Mississippi River now substitute the area of our nation with its vast estates, its little farms, its villages and town lots, all measured by acres, its great cities in which ground is measured minutely down to fractions of an inch, and consider the vast and costly records in which the titles to all this

property is set forth. Consider the area of our Western States and Territories, where under the existing Congressional surveys the divisions into townships, sections, quarter sections, &c., have become not only matters of record but actually enter into the social and political life of the people.

If three quarters of a century have done so little to obliterate the system of land-measurement at Saint Louis under the existing circumstances, what period would be required to change the present received system of the entire country to the one proposed? Left to the operation of natural causes, it is safe to say it would never be done. Were there compensatory advantages, the authority of government might be exerted to bring about such a change; but there are none. Even the facility of calculation so sought for disappears in view of the long array of figures and fractions necessary in translating the terms of one system into the terms of the other. There is nothing to compensate for the hardship and the danger that would ensue from such a change.

The existing law makes the use of the metric system permissible. Those who find it to their advantage do and will employ it. But I would not advise legislation further.

Should it appear, however, to Congress desirable to make its use obligatory, I would urge that the expense of substituting new weights and measures in the households and shops of our people is a serious item, and ought not to be made needlessly burdensome. It is probable that in the course of ten years on an average these would have to be replaced by new. A period somewhat shorter than this might be fixed upon, since a large proportion of those now in use are partially worn. Not less than five years nor more than ten is the limit I would suggest for making the use of the metric system obligatory in ordinary transactions, if this is determined upon, but for real estate transactions I look upon this change as impracticable and not to be considered.

I remain, Mr. Secretary, with great respect, your obedient servant,

ELLIS SPEAR,
Commissioner of Patents.

Hon. CARL SCHURZ,
Secretary of the Interior.

DEPARTMENT OF THE INTERIOR,
BUREAU OF EDUCATION,
Washington, D. C., January 12, 1878.

SIR: I have the honor to return herewith the copy of a resolution of the House of Representatives of November 6, 1877, respecting the adoption of the metric system of weights and measures, together with a paper prepared in accordance therewith, and am,

Very respectfully, your obedient servant,

JOHN EATON,
Commissioner.

The honorable the SECRETARY OF THE INTERIOR.

The resolution of the House of Representatives of November 9, 1877, respecting the adoption of the metric system of weights and measures, comprehends two questions, one as to the practicability of its adoption

in all governmental transactions, and the other as to the practicability of enforcing its adoption for all transactions between individuals.

I.

The first question is best answered by considering the transactions of the Federal Government with the governments and subjects of other nations apart from its transactions with its own citizens and inhabitants.

1. The transactions of the Federal Government with foreign nations and their subjects, in which weights and measures are found useful and necessary, are chiefly under the supervision of the Secretary of the Treasury and the Postmaster-General. So far as this department is informed, no greater difficulty or delay is to be apprehended if the metric system of weights and measures be substituted for those now in use than was experienced in the adoption of the gram as the unit-weight of the international postal union, now in force.

2. The Department of the Interior, while not having such vast commercial relations to the public as the Treasury, performs various duties which render the use of weights and measures necessary. Among these I mention the following:

THE DEPARTMENT IN GENERAL.

In the purchase of wood, coal, ice, gas, stationery, carpets, curtains, window-shades, &c.

In the weighing of parcels and letters for the mail.

In all publications, correspondence, &c.

THE PATENT OFFICE.

In all dimensions of drawings, models, photo lithographs, specifications, and other things relating to patents for inventions.

In the library.

THE PENSION OFFICE.

In the description of injuries or abnormal conditions on account of which pensions are applied for or granted.

THE GENERAL LAND OFFICE.

In the survey and sale of the public lands, and in the preparation of the necessary maps, charts, and papers connected therewith.

THE OFFICE OF INDIAN AFFAIRS.

In the purchase and distribution of food, clothing, medicine, &c., for treaty Indians, and in the papers and accounts connected therewith.

THE BUREAU OF EDUCATION.

For cartographic and bibliographical uses.

THE CENSUS OFFICE.

In the publications of the decimal census, wherever appropriate.

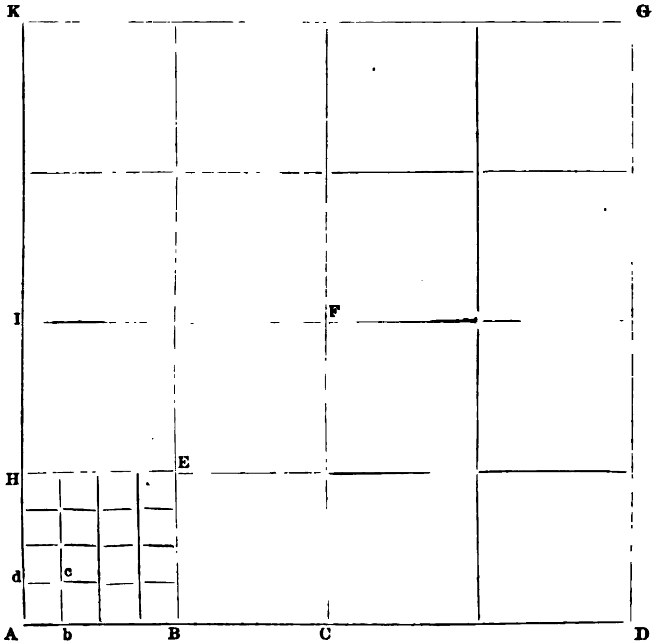
THE GEOLOGICAL AND GEOGRAPHICAL SURVEYS.

In the work of surveying and exploring, and in the construction of the maps, sections, &c., connected therewith.

THE REFORM-SCHOOL, JAIL, AND HOSPITALS.

In the record of vital and medical statistics, etc.

3. The most intimate relation which this department bears to the public is undoubtedly as the vendor of the public lands. The present system of surveying is based on the relation between the mile or unit of itinerary measure and the acre or unit of land measure, the section of one square mile containing 640 acres. Thus the survey furnishes an easily-applied measure of distances, as well as a simple and beautiful rectangular division of the public lands. These are practical advantages which should not be hastily resigned. If the hectare of the metric system be adopted as the unit of land-measure, instead of the acre, the most convenient and suitable practice would be to provide that the new section of land should consist of 256 hectares, and be a square parcel of land measuring 1,600 meters each way. The sides of this square would measure 5,249 feet 4.6912 inches, or 30 feet 7.3078 inches less than one mile. The following diagram, in which 5 millimeters represent 100 meters, illustrates this plan:



A b=100 meters; A B=400 meters; A C=800 meters; A D=1,600 meters, or 5,249 feet 4.6912 inches.

A b c d=1 hectare; A B E H=16 hectares, or $\frac{1}{16}$ section; A C F I=64 hectares, or $\frac{1}{4}$ section; A D G K=256 hectares, or 632.60112881 acres.

It will be observed that the distance A D is only 30 feet 7.3078 inches less than the United States mile, and that the section A D G K is smaller

than 1 square mile by 7.39887119 acres only. A township of 36 such sections would contain 9,216 hectares. If sold for \$3.12½ cents per hectare, the section would bring the same price as the present square mile.

II.

The second inquiry of the House committee suggests several considerations which I shall briefly review one by one; premising that the only valid reason for a change in the weights and measures of a country is the greater convenience attained. Theoretical considerations are to be discarded. In any change at the present time, three courses of action are open to us:

1. The metric system, substantially as used in France, may be substituted for our present system. Belgium, Italy, and other nations have adopted this plan. The principal practical objections to its adoption are that it would be an entire revolution of our present thoughts, apprehensions, and usages, and that the nation with which we have the closest literary, political, ethnological, and commercial connections, to wit, Great Britain, has not adopted it.

2. The standards now in use, the yard, the gallon, the bushel, the mile, and the section, may be slightly modified so as to have a metric value, easily convertible into the corresponding metric units of measure. This has been done by the German Empire. The imperial stab is a meter, the kanne is a liter, the schoppen is a half-liter, the fass is a hectoliter, the scheffel is a half-hectoliter, the pfund is a half-kilogram; these names, once belonging to many slightly different units, and thereby causing endless confusion and pecuniary loss, now have a definite and uniform value all over the empire, and their new values have been accepted, not only without objection, but with general satisfaction.

3. We may retain the yard, gallon, bushel, pound, and acre, and by the decimal system of multiplication and division derive a new and more convenient series of weights and measures therefrom. We have used the decimal system in our coinage theoretically; the series from low to high being the mill, cent, dime, dollar, and eagle; practically we use the mill only in expressing the rates of taxation (as three mills to the dollar), the cent and dollar in ordinary business, the dime as a subsidiary coin, the eagle never nowadays, as the half-eagle is a more convenient coin. We use in surveying the link of 7.92 inches and the Gunter's chain of 792 inches or 66 feet, the square chain (of 16 square rods), and the acre of ten square chains.

Sweden adopted the decimal notation some years ago. I am informed that after a full trial, that country has decided to adopt the metric system on and after January 1, 1889. This seems to indicate that the decimal notation is only a palliative measure in practice.

The metric system of weights and measures has been adopted, in one of the two ways above mentioned, by the Argentine Republic, Bolivia, Brazil, Chili, the United States of Colombia, Ecuador, Mexico, Peru, and Uruguay, in the Americas; by Austria-Hungary, Belgium, France, the German Empire, Greece, Holland, Italy, Portugal, Roumania, Spain, and Switzerland in Europe; by the British in the East Indian possessions, and by the viceroy of Egypt.

It is permitted in Great Britain and her colonies, and in our own country; these and Russia are the only commercial nations of any importance where it is not legally obligatory.

Should the metric system be adopted for ordinary use in this country, or should our standards be modified so as to be readily compared there-

with, it is obvious that the influence on certain industries would be very great.

Lumber, now sawed 16 feet long, would then probably have to be 5 meters long, an excess of nearly 5 inches; a thickness of 2½ centimeters would correspond near enough to our inch.

A cord of firewood would be 2.50 meters long, 1.25 meters wide and high, and would contain about 136 cubic feet, instead of 128, as now.

A new ton of 1,000 kilograms, equal to somewhat more than 2,205 avoirdupois pounds, would be an acceptable substitute for the "long" and "short" tons now in use.

A new gallon of 4 liters capacity, and a new bushel equal to 4 decaliters, would do away with much of the confusion inevitable under the use of the present dry and liquid measures.

The federal government can assist in the general comprehension of the metric system, preparatory to its obligatory use by the people, in various ways.

It can use it exclusively in all instruments of precision prepared for its departments, offices, and employés.

It can construct all maps, charts, and diagrams, by the system.

It can use the system in all purchases, surveys, and sales.

It can use it in all its publications, legislative, executive, and judicial.

It can require a thorough knowledge of and familiarity with the system of candidates for admission to its military, naval, medical, and civil service.

As an example of the way in which government can influence matters of this kind, I give one or two items about stationery:

Writing-paper is now generally supplied by the trade in reams containing 480 sheets; the official ream might be made 500 sheets; the weight might be expressed in kilograms; the rulings for ordinary styles one centimeter apart.

Official envelopes, and all envelopes supplied by the post-office department, could be made to carry a decimeter scale, divided into centimeters and millimeters along their lower margin, properly indicated.

Ink and mucilage might be ordered in bottles containing a liter instead of a quart.

I would also suggest that the use of the centigrade thermometer instead of Fahrenheit's, and of barometers graduated to millimeters instead of fractions of an inch, should accompany any substitution of the metric for the present system.

Some confusion in the discussion of this subject has occurred by the slightly different values given to the meter. The calculation of Capt. Alexander R. Clarke, of the British ordnance survey office, is probably the most correct, *i. e.*, that the meter is equal to 39.370432 inches.

ADDENDUM.

I am informed that Dr. Franklin B. Hough, formerly superintendent of the New York State census, has revised some interesting statistics prepared by him in regard to the different weights in avoirdupois pounds of a bushel of various commodities as provided by the laws in certain States and Territories. Appreciating the value of such a statement in connection with the subject of this paper, I have requested him to supply me with a copy of his table. This he has done, and with it has written a letter, from which the following extracts are made:

* * * I herewith submit a table of weights of a bushel of grain and other commodities,

recently prepared by me for use in a work now in course of publication designed to facilitate the preservation of statistical records of farm industries. * * *

An examination of the table will show at a glance that while in some instances sufficient uniformity exists—as, for example, in the weight of wheat, which is 60 pounds to the bushel in every case where it is mentioned—yet that there is a singular discrepancy in other cases that might lead to serious misunderstanding in dealings between citizens of different States.

As an instance of this disparity, it may be noticed that 1,000 bushels of barley, bought in the State of Kansas at 48 pounds to the bushel, would become 1,500 bushels in New Orleans, where a contract for delivery would, in the absence of agreement to the contrary, be satisfied at the rate of 32 pounds to the bushel.

In the case of rye, 1,000 bushels would, by the same transfer, become 1,750 bushels; and in other cases differences might arise which if not so great, are manifestly as unjust in the settlement of commercial accounts.

* * * Instances are not wanting of an exception to the rule in favor of certain counties, so that the statute weight of a bushel was not uniform at a given time throughout the State. An instance of this occurred in an act passed March 14, 1844, by the legislature of New Jersey, making a bushel of corn 55 pounds in Salem County, while it was 56 pounds in the rest of the State.

In one instance, an act now in force discriminates in favor of a commodity produced within the State as against the same brought from a neighboring State. This was by a law of Indiana, approved March 7, 1863, fixing the weight of a bushel of mineral coal at 70 pounds if mined within the State, and at 80 pounds if mined without and sold within the State.

As a general rule, these weights as fixed by law are declared to be intended as a standard of reference in the absence of an expressed agreement, but an instance may be cited in which this option of special contract is *forbidden*, and either one of the parties may obtain a forfeiture from the other, if he is unwilling to accept the weight as fixed by law. I refer to the act of the Maine legislature of February 17, 1874, fixing the weight of a bushel of apples at forty-four pounds, and forbidding agreement to the contrary, under a forfeiture of 25 cents to each bushel. * * *

Custom has, in some markets, already fixed upon the *cental*, or one hundred pounds avoirdupois, as a unit in the sale of grains, and if this were adopted as the measure of all commodities mentioned in the table under consideration, there would be no difficulty in adjusting prices to this standard in whatever might be bought and sold.

Referring back to the differences noticed in the weights of a bushel between different States, there can be no doubt but that an appeal to the courts of any one of the States would lead to a decision in accordance with the laws of that State in fixing the weight of a bushel of grain. It is further evident that decisions in State courts of last appeal might be as discordant upon this subject as the laws themselves.

But the Constitution of the United States provides that "full faith and credit shall be given in each State to the public acts, records, and judicial proceedings of every other State. And the Congress may by general law prescribe the manner in which such acts, records, and proceedings shall be proved, and the effect thereof."

It is easy to understand how the "manner of proof" might be provided for, much easier than to foresee in this instance "the effect thereof"; but should a case of difference between citizens of different States, arising from a misunderstanding on this subject, be brought for decision in the Supreme Court of the United States, it is evident that great difficulty would be experienced in giving that equal credit due to each State in its public acts and judicial decisions where each was equally positive and directly opposed to the other.

On carefully examining other statutes defining the weights and measures of quantities other than the bushel, we find differences between States that ought not to exist. The number of cubic inches in a struck bushel differs slightly, and the contents of a bushel of heaped measure considerably. The gallon of milk in Vermont and Massachusetts is 231 cubic inches, or "wine measure," while in New Hampshire it is 282 cubic inches, or "beer measure." The superficial area of a half-bushel (a matter of consequence in selling by heaped measure) is not uniform, and the contents of a barrel, as defined by State laws, is different in different States.

Extending these comparisons to other units of measure, we find notable discordance in the laws relating to the inspection of staves, lumber, shingles, and other forest products; differences that ought not to exist, and which are liable to lead to misunderstandings, by affording opportunities for fraud. The differences that exist between the inspection laws of the several States require a careful study before venturing upon general legislation, to the end that the true wants of the country and the equities of trade may be served without prejudice to any section or interest.

Number of pounds (avoirdupois) in a bushel of various commodities, according to the laws of certain States and Territories.

States and Territories.	Barley.	Shelled.	In the ear.	Oats.	Rye.	Beans.	Buckwheat.	Peas.	Bran.	Hominy.[5]	Meal.	Malt.	Rye meal.	Fresh.	Dried.	Dried peaches.	Blackberries.	Castor beans.	Flaxseed.	Blue grass.	Clover.	Hungarian grass.	Millet.	Timothy.	Broom-corn.	Hemp.	Osage orange.	Sorghum.
	Cereals.[1]					Legumes.			Meal, etc.					Fruits.[7]						Seeds.[11]								
		Maize.								Maize.				Apples.				Oil.			Forage.				Other.			
Arizona	45	54	....	32	56	[2]60	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
California	50	52	....	32	54	....	40	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Colorado	48	56	70	32	56	60	52	....	....	....	50	....	....	....	....	....	....	....	....	14	60	....	....	45	....	44	....	....
Connecticut	48	56	....	32	56	[2]60	48	60	....	....	50	....	50	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Dakota	48	56	70	32	56	60	40	60	20	....	....	....	....	....	....	....	....	....	56	....	60	....	....	42	30	....	....	....
Delaware	....	56	....	....	....	....	....	....	....	....	[6]44	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Illinois	48	56	70	32	56	60	52	....	20	....	48	38	....	....	24	33	....	46	56	14	60	....	....	45	....	44	....	....
Indiana	48	56	68	....	56	[2]60	50	....	....	....	50	....	....	....	25	33	....	46	....	14	60	....	....	45	....	44	....	....
Iowa	48	56	70	33	56	60	52	....	20	....	....	....	....	48	24	33	[9]32	46	56	14	60	....	45	45	30	44	32	30
Kansas	48	56	70	32	56	60	50	....	20	....	50	32	....	....	24	33	....	44	54	14	60	50	50	45	....	44	....	....
Kentucky	47	56	70	32	56	[2]60	56	60	20	....	50	....	....	....	24	39	....	45	56	14	60	50	50	45	....	44	....	....
Louisiana	32	56	....	32	32	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Maine	48	56	....	30	....	64	48	60	....	....	50	....	50	44	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Maryland	47	56	....	26	56	....	48	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Massachusetts	48	56	....	32	56	....	48	....	....	50	50	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Michigan	48	56	70	32	56	60	48	60	....	....	50	....	....	....	22	28	....	46	56	14	60	50	50	45	....	44	33	....
Minnesota	48	56	....	32	56	....	42	....	....	....	....	....	....	....	28	28	....	....	....	....	60	....	....	....	....	....	....	....
Missouri	48	56	....	32	56	60	52	....	20	....	....	....	....	....	24	33	....	46	56	14	60	....	....	45	....	44	....	....
Montana	48	56	....	35	56	60	52	....	....	....	50	....	....	....	....	....	....	....	....	14	45	....	....	44	....	52	....	....
Nebraska	48	56	70	34	56	[2]60	52	60	20	....	50	30	....	....	24	33	....	46	56	14	60	60	40	45	....	44	32	30
New Hampshire	....	56	....	30	56	60	....	60	....	....	50	....	50	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
New Jersey	48	56	....	30	56	....	50	....	....	....	....	....	....	....	....	....	....	....	55	....	64	....	....	....	....	....	....	....
New York	48	58	....	32	56	62	48	60	....	....	....	....	....	....	....	....	....	....	55	....	60	....	....	44	....	....	....	....
Ohio	48	56	70	32	56	60	50	60	....	60	....	34	....	....	22	33	....	....	56	....	60	50	50	45	....	44	....	....
Oregon	46	56	....	36	56	....	42	....	....	....	....	....	....	45	28	28	....	....	....	....	60	....	....	....	....	....	....	....
Pennsylvania	47	56	....	30	58	....	48	....	....	....	....	....	....	....	....	....	....	....	....	....	62	....	....	....	....	....	....	....
Rhode Island	48	56	....	32	56	....	....	....	....	....	50	....	50	....	....	....	[10]32	....	....	....	....	....	....	....	....	....	....	....
Vermont	48	56	....	32	56	60	46	60	....	....	....	....	....	46	....	....	....	....	....	....	60	....	....	45	....	....	....	....

Virginia	48	56	70	32	56	[4]60	52	[4]60	....	....	50	38	....	....	28	[1]40	....	....	56	14	60	48	50	45	....	44	34	....
Washington	45	56	....	36	56	....	42	....	....	....	....	....	....	....	28	28	....	....	....	....	60	....	....	....	....	....	....	....
West Virginia	48	56	....	32	56	60	52	....	....	....	....	....	....	....	25	33	....	....	56	14	60	....	....	45	....	....	....	....
Wisconsin	48	56	....	32	56	....	50	....	....	....	....	....	....	....	28	28	....	....	56	....	60	....	....	46	....	....	....	....

[1] The wheat bushel is 60 lbs., except in Rhode Island, where no weight is mentioned.
[2] Small white beans 60; other beans 55.
[3] White beans.
[4] Black-eyed peas.
[5] Hominy in Ohio, "cracked corn" in Massachusetts.
[6] Sifted meal 44; unsifted meal 48.
[7] In Virginia 22 lbs. of peanuts, or 57 lbs. of chestnuts, make a bushel; in Iowa cherries 40 lbs., peaches and quinces 48 lbs.; in Oregon pears 45 lbs.; in Michigan dried plums 28 lbs., cranberries 40 lbs.
[8] Unpealed peaches 32.
[9] Raspberries and strawberries the same, grapes, currants, and gooseberries 40 lbs.
[10] Also all other berries 32.
[11] Rape-seed in Wisconsin 50 lbs., herds grass in Iowa 45 lbs., orchard-grass in Michigan 14 lbs., red top seed in Virginia 12 lbs., cotton-seed in Missouri 33 lbs.

Number of pounds (avoirdupois) in a bushel of various commodities, according to the laws of certain States and Territories—Continued.

States and Territories.	Roots. Beets.	Carrots.	Mangold-wurzel.	Onions.	Onion-sets.	Parsnips.	Potatoes.	Sweet potatoes.	Sugar-beets.	Turnips.	Rutabagas.	Other commodities. [15] Coal mineral.	Salt.	Fine salt.	Coarse salt.	Lime.	Unslacked lime.	Hair for plaster.
Arizona																		
California																		
Colorado				57			60					80	80			80		
Connecticut		55		50		45	60		60	[14]50	60							
Dakota	60			52			60	46		60		80	80			80		
Delaware																		
Illinois				57			60	55		55		80		55	50		80	8
Indiana				48			60					70	50					
Iowa				57			60	50		55		80	50			80		
Kansas				57			60	50		55		80	50				80	8
Kentucky				57			60	45		60		76	50	55			35	8
Louisiana																		
Maine	[12]60	50	60	52			60		60	[14]50	60							11
Maryland																		
Massachusetts				52			60						70					
Michigan				54			60	56		58		80	[17]56			[21]70		
Minnesota							60											
Missouri				57		50	60					80	50					
Montana	50	50		57			60			50			50					
Nebraska				57	25		60	50		55		80	50			80		8
New Hampshire							60											
New Jersey							60											
New York							60						56					
Ohio				50			58	50										
Oregon							60											
Pennsylvania												[16]76	[18]70	[19]62	[20]85			
Rhode Island	60	60	60	[13]50	60	60	60	60	60	60	60							
Vermont	60	50		52			60			60								
Virginia				57	28		60	56		55		80	50					8
Washington	50			50			50			50								
West Virginia							60					80						
Wisconsin							60						60					

12 Turnip-beets 60.
13 All root-crops, except onions, 60.
14 Common English turnips.
15 In Pennsylvania 40 lbs. of coke make a bushel; in Iowa 130 lbs. of sand make a bushel.
16 At Pittsburgh—75 lbs. at Greensburgh.
17 Michigan salt.
18 Foreign ground salt.
19 Fine foreign salt.
20 Coarse foreign salt.
21 Stone lime.

OFFICE OF THE UNITED STATES GEOLOGICAL AND
GEOGRAPHICAL SURVEY OF THE TERRITORIES,
Washington, D. C., March 20, 1878.

SIR: In reply to your communication of March 11, asking an expression of my views in regard to the resolution of Mr. Clark, of Missouri, passed by Congress November 6, 1877, I beg to state, first, that among the majority of scientific men in all countries, a uniform system of weights and measures for the entire civilized world is held as a matter of the highest importance. As far back as 1821, Hon. John Quincy Adams used the following forcible language:

Uniformity of weights and measures, permanent, universal uniformity, adapted to the nature of things, to the physical organization and the moral improvement of man, would be a blessing of such transcendent magnitude that if there existed upon earth a combination of power and will adequate to accomplish the result by the energy of a single act, the being who should exercise it would be among the greatest of benefactors to the human race.

So far as the work of this survey is concerned, there is but little difference in the two systems. In our map-work it is unimportant whether we use meters or miles, frequently using both.

There are special cases where the metric system might be made obligatory immediately, as in the Post-Office Department, but among individuals or in English-speaking countries it would seem quite impossible to make the metric system compulsory during the present generation. Our people cannot think in that system, and must therefore consume a certain amount of time in translating from one into the other.

The metric system will probably be required to be introduced into the common schools to the exclusion of our English method.

It is believed that all objections to the metric system will be entirely overcome in the progress of the times.

Very respectfully, your obedient servant,

F. V. HAYDEN,
United States Geologist.

Hon. CARL SCHURZ,
Secretary of the Interior.

DEPARTMENT OF THE INTERIOR,
UNITED STATES GEOGRAPHICAL AND GEOLOGICAL
SURVEY OF THE ROCKY MOUNTAIN REGION,
Washington, D. C., May 3, 1878.

SIR: I have the honor to acknowledge the receipt of your letter of March 11, communicating to me the resolution of the House of Representatives, on motion of Hon. John B. Clark, jr., of Missouri, namely:

Resolved, That the heads of the executive departments of the government be, and they are hereby, requested to report to this House, at as early a date as practicable, what objections, if any, there are to making obligatory in all governmental transactions the metrical system of weights and measures, whose use has been authorized in the United States by act of Congress, &c.

In which letter you also desire me to give an expression of my opinion upon the subjects referred to in said resolution. I have the honor to reply as follows:

It appears to be the conviction of many able men who have studied the subject, that the adoption of the metric system now employed by France, Germany, and other countries, would be beneficial to the people of this country in many ways, by diminishing the labor of computation and promoting the accuracy of records and accounts, the proper keeping of which is so essential to and intimately associated with the welfare of the entire people. There can be no question that if all computations could be at once settled upon the basis of this system, and if those who

daily make use of computations were as thoroughly habituated to it as they are to the heterogeneous system now in use, the gain would be very great. On the other hand, it cannot be denied that much difficulty must be encountered and no small amount of inconvenience entailed in making the transition, and the question is resolved into the ulterior one of whether the advantages to be secured by the change would more than compensate for the difficulties of making it. While the affirmative view of this question appears to me to be the only reasonable one, I think that many difficulties may be recognized.

So far as relates to the adoption of the metric system in governmental transactions, the principal difficulties seem to me to be as follows: All of the laws of the United States which involve the records and computations of weights and measures specify the quantities in terms of the existing system. The laws relating to the duties on imports and rates of excise, other than *ad valorem*, specify pounds, tons, feet, yards, gallons, &c. The laws relating to the lands and their metes and bounds specify the current units of linear or superficial measures. In governmental transactions, rates of purchase, sale, and taxation are usually so adjusted to weights and measures as to be easily expressed in simple numbers and very simple fractions. For example, when lands are sold the price is a dollar and an easily expressed fraction of a dollar per *acre*. The duty upon cloth is a definite number of cents per *yard*. The tax on spirits is a definite number of cents per *gallon*. To change the mode of computation in these transactions to the metric system without any alteration in the present prices and rates of taxation would involve the use of inconvenient decimal fractions. To obtain that simplicity of computation which is the main object and utility of the metric system, it would be necessary to change the quantative specifications of the law. Take an example: The present tax upon distilled spirits is 90 cents per proof-gallon; if the metric system were to be employed, without any change in the rate of taxation, the law would have to read that the tax per proof *litre* should be 23.776124 cents, an incommensurable quantity more difficult to employ than the present one, and the most obvious way of meeting the difficulty would be to make a slight alteration in prices, excise, and duty rates, insufficient to affect commercial interests, but sufficient to secure the required simplicity and accuracy of specification. This difficulty does not, however, appear to be insuperable, for if Congress is fully satisfied that the gain from the use of the metric system is more than sufficient to compensate the acknowledged difficulties of its introduction, the remedy is simple and obvious.

There is another difficulty which must be apparent to all who have given the subject even a cursory examination. The government is frequently brought into relations, involving the use of weights and measures, with uneducated persons whose powers of computation are limited, and whose ideas are so thoroughly imbued with the present system that the metric system is almost beyond their grasp, and who would be compelled to rely upon the good faith and services of others in transactions where the law would hold them responsible for a full and intelligent comprehension of their own acts and their consequences. I believe, however, that we are more apt to overrate than to underrate the difficulties that may arise from this source. It is not probable in any event that legislation would be resorted to in order to introduce the metric system violently, as the fact would be recognized that the people must grow into and adopt it gradually, if at all, and that this gradual adoption would in itself furnish a reasonable safeguard against such danger.

It would no doubt be easy to suggest many sources of difficulty which

in a general way are analogous to those already stated, and of which the foregoing are intended merely as examples. If the inquiry of the committee asking for objections refers to insuperable objections, I can only state that I see none of that character.

There are certain facts worthy of consideration in this connection. A very large number, probably a great majority of all the citizens of the United States, are already so fully informed on this subject that a change to the new system is by them deemed wise. In very many of the public schools of the United States, and the private schools also, the metric system is taught; and the method of determining in units of the new system the value of quantities in the old is already familiar to the youth of the country. It is desirable that this interest in the metric system should not abate, but rather that some stimulus be given to the acquirement of a more thorough knowledge of and familiarity with it. For this purpose I consider that it would be wise to introduce its use into some departments of the government at an early date.

Having made as careful a survey as time and circumstances would permit of the general scope of government business, I have been led to the opinion that it might be introduced into governmental transactions relating to international commerce, into the postal service, and into all that portion of the business of the General Land Office which pertains to the public lands yet unsurveyed. In these branches of the government little inconvenience will be felt by private individuals, as the business will be transacted by government officers and employés who are, or should be, competent to the task. More than one-half of the whole area of the United States, including Alaska, is yet unsurveyed and undisposed of. While over a portion of this great area divisional surveys are unnecessary, yet the greater part must eventually be surveyed antecedent to the conveyance of titles to individuals.

If the metric system is finally to prevail in this country, it is desirable that these lands should be measured and conveyed in units of the new system.

While I deem it wise to introduce the new system gradually, it would be unfortunate to check the growing interest in it by a rapid change that would at once precipitate on the people all the difficulties inevitable to the transition. The final accomplishment of this good might thereby be indefinitely postponed.

Should it be thought desirable to introduce the new system more extensively into the business of the government, I would suggest that it might be adopted in transactions relating to the internal revenue and government transportation; but the same precaution should be used in these cases as in those mentioned above, namely, that in the quantative specifications of the law, and all contracts made under the law, rates should be adjusted to quantities, so as to be expressed in a simple manner; for if this is neglected the new method will be so burdensome as to bring the system into popular disrepute. I entertain the opinion, however, that it will be wiser to postpone its introduction in the latter-mentioned cases until it has been thoroughly tried in the former.

The resolution of the committee also inquires, "How long a preliminary notice should be given before such obligatory use can be introduced without detriment to the public service?" So far as it relates to transactions between the government and individuals, I see no reason why, if it is to be introduced at all, it cannot be introduced now to the extent mentioned above, giving only such preliminary notice as would be necessary to make all persons who may be concerned fully apprised

of the intention of the government. For this purpose a single year will, in my opinion, be ample. It should be borne in mind, in this connection, that the transactions of the government differ from those between individuals in the following important particulars: They are more deliberate, and are matters of record, involving no dangers nor difficulties except such as the intelligence of its employés is presumably quite adequate to meet, whereas the transactions between individuals, over the counter of the retail store, on the street, or in the farm-yard, are frequently without record or voucher, and sometimes made by individuals of small education. In such cases a sudden change in the basis of weights and measures might produce serious embarrassments.

The resolution further inquires, "What objections there are, if any, to making the metrical system obligatory in all transactions between individuals; and what is the earliest date that can be set for the obligatory use of the metrical system throughout the United States?" To the first part of this question one general and comprehensive answer may, I think, be given—that the only objection is the inconvenience of making the change. The magnitude of this objection is a purely practical question, which legislators are, of all men, probably the most competent to estimate correctly.

In all business transactions relating to machinery and architecture, and in the practical use of the metric system in these industries, the inconvenience will be great. In land measures its introduction will but slightly inconvenience the people at large, for the measurement of land is practically relegated to skilled persons, as engineers and surveyors; and the conveyancing of lands, to persons skilled in that branch of business.

These examples will illustrate the nature of the problem to be solved. It is one of exceeding complexity affecting many interests in diverse ways, and I deem it wise to postpone the subject of making the new system obligatory between individuals to some future time, until experience in its practical use by the government shall more fully demonstrate the many advantages to be derived therefrom.

If the general use of this system is eventually compelled by law it will be reasonable to retain for a considerable time the legality of both systems prior to the last step in the transition. This will involve a contemporaneous use of the two systems, in itself a serious inconvenience. This, however, is obviously a part of the price which the government and people will be compelled to pay for ultimate accomplishment of a good work.

In the above statement the wisdom of adopting the metric system is postulated. As long as we have a denary or decimal system of numeration, a decimal system of weights and measures is the most simple and convenient. Improvements might be suggested in the new system, as a decimal system, but from the fact that such improvements are of minor importance, and the further fact it is adopted already by some great and enlightened nations, these considerations have slight weight, and an attempt to introduce a new system of numeration as well as a new system of weights and measures would be a change of such magnitude that it may be well at present to consider it impracticable.

I am, with great respect, your obedient servant,

J. W. POWELL,
In Charge United States Geographical and Geological Survey, Rocky Mountain Region.

Hon. CARL SCHURZ,
Secretary of the Interior.

STEAMER VIRGINIUS.

MESSAGE

FROM THE

PRESIDENT OF THE UNITED STATES,

TRANSMITTING,

In compliance with a resolution of the House of Representatives of February 21, a report from the Secretary of State in reference to the seizure of the steamer Virginius.

APRIL 1, 1878.—Referred to the Committee on Foreign Affairs and ordered to be printed.

To the House of Representatives:

I transmit herewith, in compliance with a resolution of the House of Representatives of the 21st ultimo, a report from the Secretary of State and its accompanying papers.

R. B. HAYES.

WASHINGTON, *March* 29, 1878.

NOTE.—Correspondence between Government of United States and Spain, in reference to seizure of the steamer Virginius, &c.

DEPARTMENT OF STATE,
Washington, March 26, 1878.

To the President:

The Secretary of State, to whom was referred the resolution of the House of Representatives of February 21, 1878, requesting the President, "if not incompatible with public interest, to transmit copies of all correspondence between the Government of the United States and Spain, not hitherto communicated, in reference to the seizure of the steaner Virginius, and the massacre of a portion of the passengers and crew of the same, and to inform the House whether Brigadier-General Burriel has been tried by the Spanish authorities, in accordance with the agreement of the Spanish Government," has the honor to transmit, in answer to the said resolution, the accompanying papers, including a translation from a paragraph in the "Diario de la Marine" of the 15th of January last, announcing the death of General Burriel.

WM. M. EVARTS.

Accompanying papers.

1. Mr. Cushing to Mr. Fish, February 5, 1876.
2. Mr. Fish to Mr. Cushing, March 4, 1876.
3. Mr. Cushing to Mr. Fish, April 12, 1876.
4. Mr. Cushing to Mr. Fish, April 21, 1876.
5. Mr. Cushing to Mr. Fish, April 21, 1876.
6. Mr. Fish to Mr. Cushing, May 17, 1876.
7. Mr. Cushing to Mr. Fish, June 12, 1876.
8. Mr. Cushing to Mr. Fish, February 8, 1877.
9. Mr. Cushing to Mr. Fish, February 22, 1877.
10. Mr. Evarts to Mr. Cushing, March 21, 1877.
11. Mr. Cushing to Mr. Evarts, April 4, 1877.
12. Translation from the "Diario de la Marina."

No. 1.

Mr. Cushing to Mr. Fish.

No. 805.] LEGATION OF THE UNITED STATES,
Madrid, February 5, 1876.

SIR: D. Juan Burriel has been relieved from duty at Bilbao and ordered to Madrid to look after his ***health***, to wit, the proceedings against him and his associate wrong-doers pending in the council of war.

General Cassola takes his place at Bilbao, and, under the superior command of General Moriones in the military operations in Vizcaya, is winning laurels, which might otherwise have fallen to General Burriel.

I have, &c.,

C. CUSHING.

No. 2.

Mr. Fish to Mr. Cushing.

No. 325.] DEPARTMENT OF STATE,
Washington, March 4, 1876.

SIR: Referring to your dispatch No. 805, under date of the 5th ultimo, stating that General Burriel has been relieved from duty at Bilbao and ordered to Madrid in connection with the proceedings pending against him in the council of war, I have to state that similar statements have reached this country through the public print. It is hoped that the investigation of this officer will be taken up, prosecuted, and concluded without delay.

I am, &c.,

HAMILTON FISH.

No. 3.

Mr. Cushing to Mr. Fish.

No. 906.] LEGATION OF THE UNITED STATES,
Madrid, April 12, 1876. (Received May 3.)

SIR: I have the satisfaction of now transmitting to you herewith copy and translation of a note just received from the minister of state, by which you will learn that the King's government, doubtless moved thereto by the recent pressing communications of mine on the subject, official and unofficial, * * * * *

* * has at length taken decisive steps to relieve itself of the embarrassments produced by the delays, whether of willfulness or of negligence only, of the council of war in the matter of the arraignment of Burriel and his associates for the outrages committed at Santiago de Cuba.

Legal forms in most countries are the great impediment to the administration of justice. In Spain it is just announced only now that, after the expiration of more than five years, the prosecution of the assassins of Prim is about to pass from its preliminary stage of preparation (*sumario*) into that of action (*plenario*); and we in the United States have had a similar case of juridical procrastination in the matter of Tweed.

I do not intend, if it be possible to prevent it, to suffer further delays in the present matter; and therefore propose to continue to follow up the question urgently, and in sign thereof have addressed a note to the minister of state, a copy of which is annexed.

I have, &c.,

C. CUSHING.

[Inclosure 1 in No. 906.—Translation.]

Mr. Calderon y Collantes to Mr. Cushing.

MINISTRY OF STATE,
The Palace, April 11, 1876. (Received April 11, 8 p. m.)

EXCELLENCY: I have the honor to pass to the hands of your excellency the accompanying copy of the communication which, under this date, I address to my colleague, the minister of war, asking him to be pleased to dictate the opportune orders, to the end that there be initiated in this capital the proceeding in conformity with the clause of the protocol of Washington to which the said communication refers.

I avail myself, &c.,

FERNANDO CALDERON Y COLLANTES.

[Inclosure in 1 in No. 906.]

MINISTRY OF STATE.

EXCELLENCY: The grave question to which the capture of the Virginius in the waters of the island of Cuba gave rise terminated with a protocol, signed in Washington on the 29th day of November, 1873, between Rear-Admiral Don José Polo de Bernabé as the representative and envoy extraordinary and minister plenipotentiary of Spain near that government, and Hamilton Fish, as the Secretary of State. One of the clauses of that protocol is literally as follows:

"It being understood that Spain will proceed, according to the second proposition made to General Sickles, and communicated in his telegram read to Admiral Polo on the 27th instant, to investigate the conduct of those of her authorities who have infringed Spanish laws or treaty-obligations, and will arraign them before competent courts and inflict punishment on those who may have offended."

Subsequently, in the note addressed on the 3d day of December, 1874, by our minister of state to the minister plenipotentiary of the United States at this court, a statement was made, which is also literally as follows:

"The government desires and is disposed to comply in every point with all the stipulations contained in the protocol of the 29th of November, 1873 (which is the one I have just cited); and considering the contents of the second proposition made by (*sic*) your excellency's predecessor in your legation as one of the elements of the complete and final settlement of the question which occupies us, it will proceed to give the proper orders, to the end that, by the competent tribunal, shall be instituted an inquiry with respect to the conduct of the authorities of Santiago de Cuba who intervened in the conduct of the trial and sentence of the American citizens who were executed in that city, exacting of them the responsibility which they may have incurred for infractions of law or of international treaties."

The present is not the fitting occasion for examining the protocol referred to; it suffices to know that it constitutes an obligation on the part of the Spanish Government, ratified, although it was not necessary to do so in order to comprehend that it must be religiously fulfilled with promptitude and in good faith, although, for causes foreign,

doubtless, to the will of the government of His Majesty, it has not yet come to be executed after the long period of time which has elapsed. This is demanded by the consideration and respect which we owe to all friendly nations and governments, and by the honor of Spain, involved in the loyal fulfillment of her pledges.

With this object, there was requested, through the worthy predecessor of your excellency, a report (*informe*) from the supreme council of war, and the latter, in its turn, called for it from the fiscal tribunal of the same branch of service in the island of Cuba; which report has not yet been rendered.

This delay cannot justify the backwardness of the fulfillment of the compact made with the Government of the United States; and therefore, by order of His Majesty the King, (whom may God guard!) I have the honor to address myself to your excellency, in order that you be pleased to dictate the opportune orders to the end that there be immediately initiated in this capital the proceedings in conformity with the above-inserted clause of the protocol of Washington.

This being done, the fiscal of the tribunal, or else the person who may be named according to the prescriptions of our military law, can call for the data and documents of reports which he may judge necessary in order to insure the justice of the finding which may result; and even if it should appear that it is another tribunal which ought to have cognizance in the matter, there can and should be remitted to the latter, according to the legal prescriptions and incontrovertible jurisprudence in this respect, the papers and proof which may have been obtained.

The gravity and urgency of this matter lead me to hope, in view of the enlightenment and rectitude of your excellency, that you will not delay the adoption of the measures I have just indicated, communicating the same to me, in order that I may make them known to the minister plenipotentiary of the United States at this court.

God grant your excellency many years.

The Palace, April 11, 1876.

FERNANDO CALDERON Y COLLANTES.

The Señor MINISTER OF WAR.

[Inclosure 2 in No. 906.]

Mr. Cushing to Mr. Calderon y Collantes.

LEGATION OF THE UNITED STATES,
Madrid, April 12, 1876.

SIR: I have received with lively satisfaction your excellency's note of the 11th instant, informing me of the decisive step adopted in the affair of Santiago de Cuba, and have lost no time in communicating the same to my government, which will not fail to see in this act proof of the good faith and sense of justice of His Majesty's government.

Your excellency's communication to the ministry of war sets forth in language unanswerable the considerations of national honor which induce the present action. I cannot permit myself to doubt that not those weighty considerations only, but the sentiment of public duty as well, for which his excellency the minister of war is so highly distinguished, will impel him to give immediate effect to this explicit instance of the King's government in the premises. Will your excellency permit me to add some pertinent suggestions?

The government of His Majesty has thus far been eminently one of national reparation, of political reconstitution, of social reorganization for much-afflicted Spain. It has victoriously subdued armed rebellion in Valencia, Cataluña, Navarra, and the Basque provinces. It has maintained domestic order in the residue of Spain. It has resolutely encountered that greatest of all other dangers for Spain in modern times, the convocation of the Córtes and the discussion of a new written constitution. It sincerely aims to accomplish the great and difficult object of reconciling freedom with order, tolerance with religion. It desires that, without ceasing to cultivate manifestations of high intelligence, eloquence, literature, science, the fine arts, Spaniards should learn also to cultivate material interests in common with the other great peoples of Europe. It labors to counteract the hereditary predisposition of Spaniards to revolts, to insurrections, to civil war, and to persuade them to believe that

Peace hath her victories no less renowned than war.

In fine, His Majesty's government would fain lead Spain onward and upward to her merited seat in the grand concert of the civilized nations of the world, through the "golden gate" of dignity, honor, and self-respect; to do which it needs that she shall at all hazards acquire stability of domestic government; that she shall cease to squander her resources in sterile civil wars; in fine, that she shall possess herself in order that her voice may again be as potential, if not as it was in the heroic days of the Catholic kings and of Charles I, yet at least as much so as in the hardly less glorious ones of Charles III.

Are not such the lofty and patriotic aspirations of His Majesty and of his government? I know they are. And hence it is that to-day Spain receives from all the foreign powers of Europe and America, monarchical and republican alike, testimonies of reawakening confidence, such as she has not heretofore enjoyed since the commencement of her public disasters in the flagitious invasion of her by foreign armies in the execution of the semi-insane projects of ambition of the Emperor Napoleon.

Will Spain succeed in this mighty effort to at length repossess herself, and so to convert the hopes of other nations respecting her into assured faith? I sincerely trust that she will; and this last act of His Majesty's government encourages me in this respect. For permit me to say not the United States only, but other powers also, have been waiting for more than two years in solicitous expectation of *some* government in Spain having will and strength to execute international conventions involving the possible censure of an officer of the Spanish army.

The United States, Great Britain, Germany, do not hesitate to try, to cashier, and, if need be, to execute an officer of the army or navy guilty of dereliction of duty, especially if the act be injurious to foreign powers.

We of the United States, republic as we are, have done this repeatedly, and in signal cases at the instance of Spain. And shall regenerated Spain fail in this respect? No, says my government; no, say other governments, not if she has in truth entered on the path of regeneration.

I touch, and but touch, on a point of the domestic policy of Spain, because it is of the essence of the pending question between the two governments.

It may be that the considerations adduced in this note are outside of the cold and stiff commonplaces of ordinary diplomatic discussion. Be it so. But those considerations do but present the true arguments on which the pending question turns. And must the discussion between two friendly governments be so restricted by vain diplomatic forms as to be forced to pretermit all arguments of reality and truth? No; a thousand times no; provided the two governments sincerely desire, as we do, to maintain good understanding.

In other fields of discussion we make use of the arguments which the conditions of the question require and which we deem the best fitted to express our own conviction and to produce similar conviction in the minds of others. Why, in the most important of all discussions, diplomatic argument between sovereign states, involving, of course, possible issues of peace and war, should we be deprived of the full use of reason?

Thus to sacrifice substance to supposed exigencies of mere form would be, according to one of the current proverbs of my country, to represent the drama of "The Prince of Denmark" with the part of Hamlet omitted; or, localizing the illustration, to give "La vida es sueño," leaving out the prince.

I venture, therefore, with reservation at the same time of all possible intention of respect for His Majesty's government and for your excellency, to put forward what, in my opinion, is the impressive aspect of the present subject, and which it would be insincere in me not to express in plain words, in a conjuncture where distinct perception of the truth is of equal moment to both governments.

Meantime I assume that the ministry of war will promptly respond to the incitation addressed to it by your excellency, and that thus an apparently limited, but really grave, question will cease to encumber the relations of our respective governments.

I augur still more good from this manly act, namely, that His Majesty's government will now, relieved as it is of its enormous burden of civil war in the Peninsula, incline itself to adopt wise measures for the termination of the deplorable contest in Cuba, which, while pre-eminently calamitous for Spain, is likewise, although in a less degree, a calamity for the United States.

I avail myself, &c.,

C. CUSHING.

No. 4.

Mr. Cushing to Mr. Fish.

No. 918.] LEGATION OF THE UNITED STATES,
Madrid, April 21, 1876.

SIR: Please to receive herewith copy and translation of a note from the minister of state, in response to mine of the 12th instant regarding Burriel, transmitted to you with my No. 906.

I have, &c.,

C. CUSHING.

The Hon. HAMILTON FISH,
Secretary of State.

[Appendix B, No. 918.]

Mr. Calderon y Collantes to Mr. Cushing.

MINISTRY OF STATE,
Madrid, April 19, 1876. (Received April 20, 1876.)

EXCELLENCY: SIR: With no less satisfaction than that wherewith your excellency assures me you received my note of the 11th of the current month, have I received that of your excellency of the 12th, since nothing can be more in correspondence with my lively and ardent aspirations than to see drawn closer day by day the cordial relations between the United States and Spain.

Far from feeling surprise at the form and style in which your excellency so ably as well as so honorably conducts the important affairs committed to you, and in which your notes are couched, no less than the form and style which you employ in your diplomatic conversations with me, I applaud them sincerely, and confess that they have contributed with great efficiency toward setting in the favorable state in which they now are the relations between the Government of the Union and that of His Majesty.

I venture, therefore, to beg of your excellency that you will continue to employ them, certain of their always being very well received, because, while not coming short (and this fear cannot be entertained) of the duties of mutual consideration and respect, the foundation and substance of things ought not to be sacrificed to determinate formulas.

Conforming in every respect with the opinion of your excellency, I avail myself of this opportunity to reiterate to you the assurances of my most distinguished consideration.

FERNDO. CALDERON Y COLLANTES.

The MINISTER PLENIPOTENTIARY *of the United States.*

No. 5.

Mr. Cushing to Mr. Fish.

No. 921.] LEGATION OF THE UNITED STATES,
Madrid, April 21, 1876. (Received May 8.)

SIR: I have just received from the minister of state a note, dated today, copy and translation of which are annexed hereto, informing me that the supreme council of war has declared itself competent to try the case of Burriel, and has formally instituted the corresponding proceedings and appointed a prosecuting officer and secretary.

I have, &c.,

C. CUSHING.

[Inclosure in No. 921.—Translation.]

Mr. Calderon y Collantes to Mr. Cushing.

MINISTRY OF STATE,
Madrid, April 21, 1876. (Received April 21, 3.30 p. m.)

EXCELLENCY: SIR: I have the honor to inform your excellency that, in virtue of the communication which I passed to the ministry of war, and of which I transmitted to your excellency literal copy, claiming the immediate fulfillment of the convention with the government so worthily represented by your excellency at this court, contained in the protocol signed at Washington on the 29th day of November, 1873, concerning the judicial proceedings against those who may prove to be culpable for the consequences to which the seizure of the Virginius gave rise, the supreme council of war, to which the señor minister of that department passed my above-mentioned communication, has declared itself competent to have cognizance of the cause.

In initiation thereof, and in consideration of its importance, it has appointed as fiscal in the cause the robed minister of the same supreme council, Don Carlos Apolinario Fernandez de Sonza, and as secretary him who already is secretary of that high body, Brigadier Don Francisco Aguirre.

With this remains fulfilled on the part of the government of His Majesty the obligation which was contracted toward the Government of the United States by the aforesaid protocol of November, 1873. The rest remains exclusively in the charge of the supreme council, which is the most elevated body in its department in our country, and which, as a tribunal of justice, will proceed according to its usages, and with absolute independence of the executive power, in the pursuance of the principle universally recognized in countries governed by liberal institutions.

In the midst of the pain caused to me by the memory of the acts which gave origin to the before-mentioned protocol, it is a source of satisfaction to me that it is the government of which I have the honor to form part which gives due fulfillment thereto as a proof of the honorability and loyalty wherewith it endeavors to fulfill, and will fulfill, all obligations contracted.

I avail myself of this occasion to reiterate to your excellency the assurances of my most distinguished consideration.

FERNANDO CALDERON Y COLLANTES.

The MINISTER PLENIPOTENTIARY *of the United States*.

No. 6.

Mr. Fish to Mr. Cushing.

No. 365.]

DEPARTMENT OF STATE,
Washington, May 17, 1876.

SIR: I have the honor to acknowledge the receipt of your dispatches 918 and 921, in reference to the case of Burriel.

With your No. 921 is inclosed a note from the minister of state bearing date the 21st April ultimo, informing you that the supreme council of war has declared its competency to have cognizance of the case of Burriel, and has appointed a fiscal and a secretary for its prosecution. The minister, thereupon, says: "With this remains fulfilled, on the part of the government of His Majesty, the obligation which was contracted toward the Government of the United States by the aforesaid protocol of November, 1873"; and adds, that the rest remains exclusively in the charge of the supreme council, which will proceed with absolute independence of the executive power.

Although the exact words of the note of the minister of state would seem to imply that the discovery of a tribunal having jurisdiction of the case, and the appointment of a fiscal and secretary, is, of itself, a performance of the obligation assumed in the protocol, it is not apprehended that such was the intention of the minister of state. The protocol of November 29 provided that "Spain will proceed according to the second proposition made to General Sickles, and communicated in his telegram read to Admiral Polo on the 27th instant, to investigate the conduct of those of her authorities who have infringed Spanish laws or treaty obligations, and will arraign them before competent courts and inflict punishment on those who may have offended." The Government of Spain has, as it appears, now only determined on the tribunal before which the parties can be arraigned, and through which proper punishment can be inflicted; and in so doing Spain has, after a delay of two years and a half, taken a preliminary step toward the fulfillment of her obligations by this protocol. I have not learned as yet that any person has been arraigned before the tribunal in question, much less that any investigation has been had or any punishment inflicted. The Government of the United States has been unable to comprehend any good reason for delay, and receives with satisfaction the intelligence that Spain has taken this preliminary step referred to, but it is hoped that

it is not intended to be stated that this step so taken is the performance of the entire obligation, and that the Government of Spain will appreciate that her obligation is to arraign the individuals who have offended, and to punish those who have violated her laws and treaty obligations.

In order that no doubt may exist on this question, you are instructed to call the attention of the minister of state to these expressions in his note, and to convey the hope of this government that, after the delay which has occurred in these preliminary steps, the remainder of the obligation will be promptly fulfilled.

While the United States has made no claim that the executive should control the tribunal and its decision, there can be no doubt that the obligation assumed requires that the matter be proceeded with, and, if the parties be found guilty, that they be punished. An initiation of an investigation cannot be a performance.

I am, &c.,

HAMILTON FISH.

No. 7.

Mr. Cushing to Mr. Fish.

No. 981.] LEGATION OF THE UNITED STATES,
Madrid, June 12, 1876. (Received June 29.)

SIR: Bearing in mind that the officers of the Tornado, equally with D. Juan Burriel, in fact if not in official responsibility, and, indeed, with anteriority to him in the course of events, are implicated in the execution of the ship's company and the passengers of the Virginius, it is interesting that the legal proceedings in the cause have taken another step, it being announced that "the expediente drawn up on account of the occurrences on board the Tornado, after the capture of the Virginius, have been referred for report to the supreme tribunal of the navy."

I have, &c.,

C. CUSHING.

No. 8.

Mr. Cushing to Mr. Fish.

No. 1169.] LEGATION OF THE UNITED STATES,
Madrid, February 8, 1877.

SIR: I called on the minister of state yesterday for the special purpose of reminding him of the case of Burriel, and expressing to him, as I did, the urgent necessity of my being enabled to give explanations to you of the progress of the case to arrive before the close of the administration of President Grant.

He took note of my observations, and promised to give me the desired information at our next interview.

I have, &c.,

C. CUSHING.

No. 9.

Mr. Cushing to Mr. Fish.

No. 1187.] LEGATION OF THE UNITED STATES,
Madrid, February 22, 1877.

SIR: I apprised you in my No. 1169, of the 8th instant, of my having, in personal conference, expressed to the minister of state the necessity of my being able to convey to you some explanation of the present state of the proceedings against the military authorities of Santiago de Cuba in the matter of the Virginius, and of his promise to procure for me the desired information.

In consequence of all which, Mr. Silvela allowed me to-day to make transscript, of which copy and translation are annexed, of a communication addressed to him, on the 20th instant, by Lieutenant-General Marchesi, president of the supreme council of war, before which the proceedings are pending.

I observe that General Marchesi, apart from his high military rank and the important official position which he occupies, is, among the personages of his class, the most esteemed and respected in Spain.

Hence, in view of the statement he makes of the progress of the cause, and of the prospect of its early conclusion, we may confidently believe his assurance that the proceedings are not colorable merely, but conducted seriously and in good faith.

And if the inquiry shall have been completed within a year or so of the time of its initiation, that is, April, 1876, it will constitute an example of dispatch in such matters quite unaccustomed in Spain.

I have reason to believe that, while Burriel and the other officers implicated labored to stave off the investigation prior to the time when it was made imperative by royal order, yet that, since then, the same persons have been rather desirous to see it expedited and concluded.

It will not be impertinent for me to say that the delay in receiving data from Cuba in this affair reminds me of the disorder and confusion which the insurrection in that island has introduced into all its relations with the metropolis; as illustrated by the fact, which I learned in making some inquiries to-day on another subject, that, while the public accounts of receipts and expenditures for the island of Puerto Rico have been received for auditing and controlling in the Tribunal de Cuentas down to 1875, none have been received since 1870 from the island of Cuba.

I have, &c.,

C. CUSHING.

[Inclosure in No. 1187.—Translation.]

Lieutenant-General Marchesi to Mr. Silvela.

[Private.]

SUPREME COUNCIL OF WAR.

DEAR SIR AND DISTINGUISHED FRIEND: Having before me your very polite letter of the 17th instant, I had brought to me for inspection the summary proceedings, which, since the 15th of April of last year, have been followed, in this council, over which I preside, in obedience to the royal order of the 12th of the same month, to the end of duly fulfilling the compact with the United States in the protocol executed in Washington on the 29th of November, 1873, and with the object of ascertaining whether the military authorities Santiago de Cuba, who took part in the substantiation of the process and sentence of the passengers of the steamer Virginius executed

in that city, infringed Spanish laws or international stipulations with respect to American citizens.

From the examination of that cause, which, in effect is instituted by the robed minister of this council, Don Carlos Apolinario Fernandez de Souza, as *juez instructor* (judge instructor), and of which he gave account to the same council in full meeting several months ago, it appears that, being subsequently passed to the military and robed fiscals, the latter asked as necessary that documents and antecedents on record in Cuba should be sent for, for which reason they were called for from the authorities of that Antilla; and their remission has just been recalled to mind.

As the *juez instructor* informs me, those antecedents are alone wanting in order to be able to terminate the investigation, so that it is to be hoped that very soon this council may form its judgment thereon and dictate its decision in justice, which I shall have the honor to communicate to you officially through the channel of the minister of war, so that you may inform the representative of the United States thereof, and, as is your desire, demonstrate anew to him that Spain does not fail in obligations which she once assumes.

I could well have wished that the remoteness of the place where the act took place, and the multitude of antecedents, which it has been necessary to assemble for the formation of a carefully considered and upright judgment, might have allowed of its being at the same time as speedy as my desire.

I have, by reason of this occasion, the pleasure of repeating myself your always affectionate friend and obedient servant, Q. B. S. M.,

JOSÉ MARIA MARCHESI.

FEBRUARY 20, 1877.

His Excellency the MINISTER OF STATE.

No. 10.

Mr. Evarts to Mr. Cushing.

No. 525.]

DEPARTMENT OF STATE,
Washington, March 21, 1877.

SIR: Your No. 1187 has been received. It transmits a copy of a report from the supreme council of war to the minister of state, concerning the progress which has been made in the investigation into the conduct of General Burriel and the other persons responsible for the execution of the prisoners taken on the Virginius, in accordance with the protocol of November 29, 1873. From this report it appears that the authorities to whom the investigation has been intrusted have demanded "that documents and antecedents on record in Cuba should be sent for;" that these have been called for from the authorities in Cuba, and as no response has been received the matter has been recalled to the attention of those authorities.

It would therefore seem that little, if anything, has practically been accomplished before the tribunal.

I could have hoped, after all that has taken place with reference to this question, that the authorities in Spain might have been fully informed as to the facts, and can only repeat that it seems due to Spain as well as to the United States that the obligations of this protocol should be at least fulfilled.

I am, &c.,

WM. M. EVARTS.

No. 11.

Mr. Cushing to Mr. Evarts.

No. 1216.] LEGATION OF THE UNITED STATES,
Madrid, April 4, 1877.

SIR: Since my dispatch No. 1169, on the subject of Burriel, I have had an interview with Lieutenant-General Marchesi, president of the supreme council of war, which confirms my impression of the good faith of the action of that body, as stated in that dispatch.

The slowness of proceeding in all criminal cases of the class which we call "state trials" is proverbial in Spain.

An example of it is now before me in the case of General Nouvilas, charged with misconduct in the field in 1873, which case now, at the end of nearly four years of preparatory proceedings, has but just reached the point of hearing.

The proceedings against the assassins of General Prim, commenced in 1871, are still pending.

So are those instituted in 1872 against the persons who attempted to assassinate King Amadeo.

These delays are the subject of frequent complaint in Spain, among law-writers, and in the newspaper press, of which an example is annexed in some remarks of an eminent jurist, D. Francesco Lastres.

I have, &c.,

C. CUSHING.

No. 12.

[Translation.—From the Diario de la Marina, Havana, January 15, 1878.]

DEATH.

As we have seen with regret in the Madrid journals, there has died the most excellent Señor Field Marshal* Don Juan Burriel, president of the qualifying junta of the mobiliary corps organized during the epoch of the civil war, and which office he held at the time of his death, and late governor of Matanzas and Santiago de Cuba, in which latter city he gave proofs of the firmness of his character in the events which supervened when the filibuster Virginius was seized in those waters. May the earth be light upon him!

* *Mariscal de Campo*, a grade corresponding to our major-general; the next grade above that of brigadier-general. General Burriel died December 24, 1877.

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